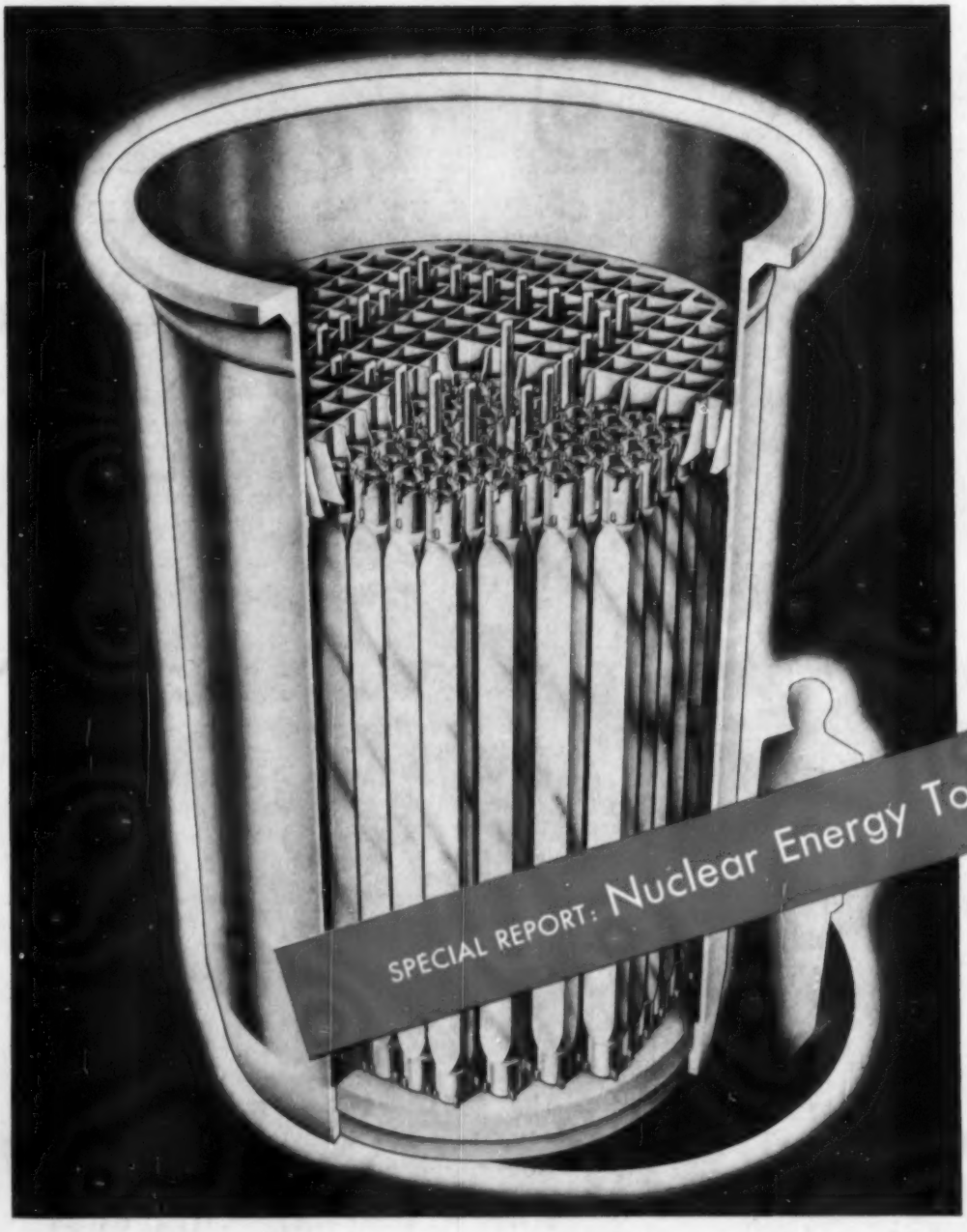
For Chicago's tallest building . . .

LAST WORD IN POWER SERVICES ▸ 97

Power

DECEMBER
1955·50¢

GENERATION, TRANSMISSION AND APPLICATION OF THE POWER SERVICES • A McGRAW-HILL PUBLICATION



SPECIAL REPORT: Nuclear Energy Today ·73

BUT THERE IS A LOW COST WAY TO STOP POLLUTION...

WITH THE A-S-H LOW PRESSURE SYSTEM

Most pollution control systems—high pressure systems—are expensive—expensive to install, costly to maintain, costly to operate.

The most efficient and economical answer to pollution control problems—*where ash or dust is the contaminant*—is the A-S-H Low Pressure Hydraulic Recirculating System. You will save money four ways:

1. On Installation. A-S-H designed systems are simpler, require less expensive components and are more easily installed.

2. On Operation. Power consumption is low. One A-S-H *Hydroseal Ash Pump* is sufficient for most systems.

3. On Water. Where water is scarce, the system can be completely closed, eliminating any outflow of polluted water and requiring only a minimum of water for make-up.

4. On Maintenance. No periodic cleaning is required. Wearing parts last longer on A-S-H *Hydroseal Ash Pumps*, which means lower replacement costs.

If you have a problem involving ash or dust disposal, do not overlook the advantages of A-S-H Low Pressure Systems. An A-S-H Materials Handling Engineer will be glad to discuss your problem with you—without obligation, of course.

The **Allen-Sherman-Hoff** Company

259 E. Lancaster Ave., Wynnewood, Pa.

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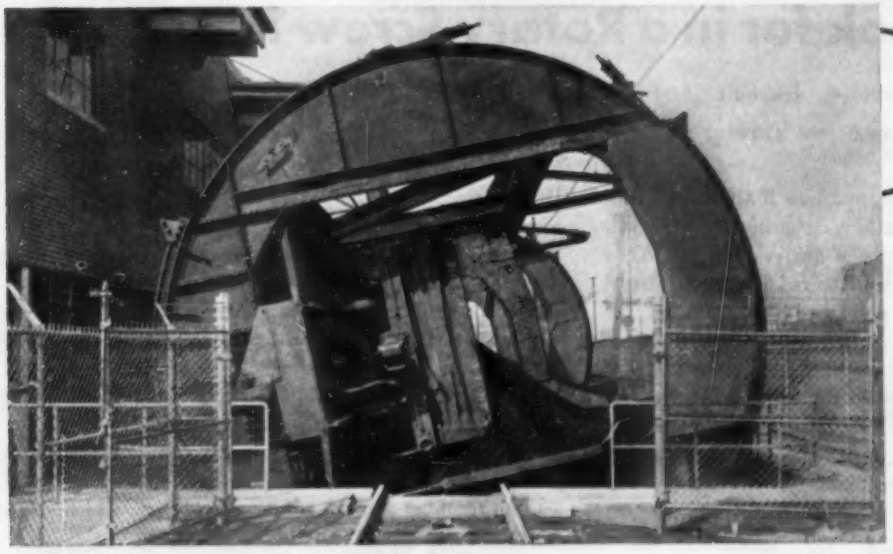
MATERIALS HANDLING SYSTEMS

hydrojet *hydraulic* / **hydrovac** *pneumatic*

How many railroad cars does your plant unload?

15 or more cars per day?

Car Shakers. Cut unloading time, free manpower. For example, where a load of wet coal ties up three men for ¾ of an hour, one man with a Link-Belt Car Shaker can empty the car "broom-clean" in minutes. Exclusive low-frequency vibration minimizes noise . . . is easier on cars. Write for Book 2345.



15 or more cars per hour?

Rotary Dumpers. Empty a 90-ton gondola car every 60 seconds or less (including return to upright position) by turning car upside down! Simple, automatic, foolproof. Takes all open-type cars — any length, width or height. Book 2048-A has complete data.

Choose the LINK-BELT Car Shaker or Rotary Dumper that meets your operating needs

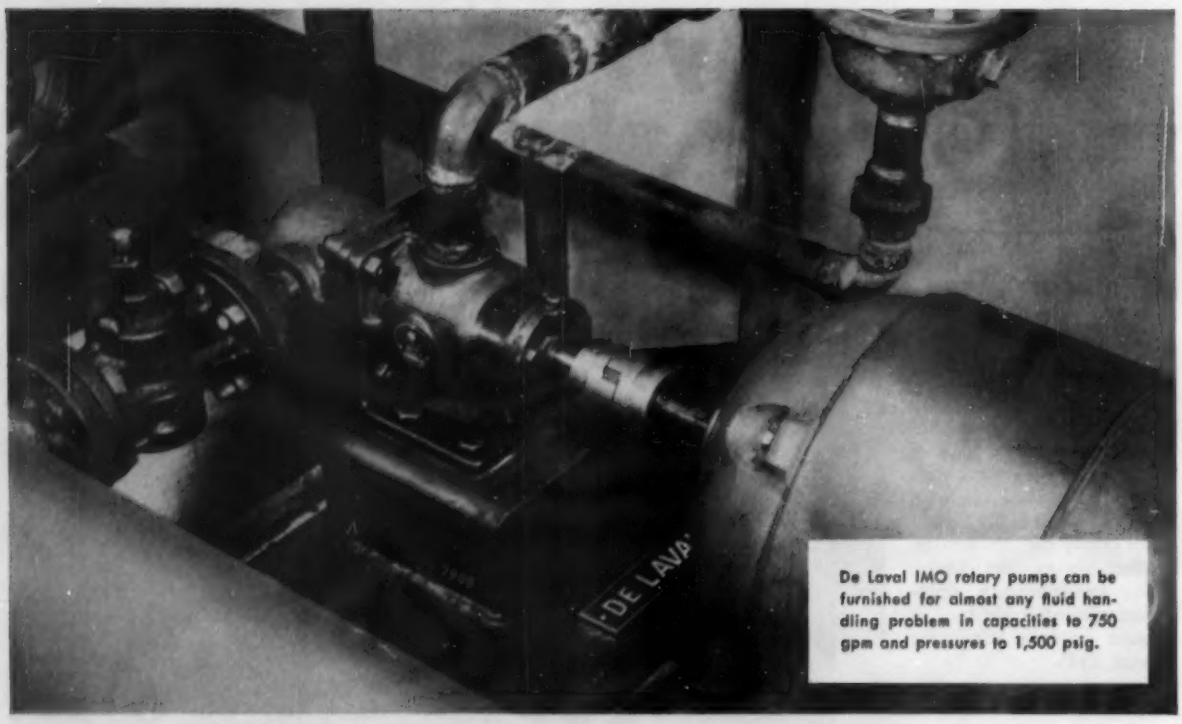
Push-button emptying of gondola cars is a sure, simple step to substantial time and manpower savings. And only Link-Belt builds car shakers *and* rotary dumpers . . . to meet all unloading needs, from the largest to the smallest. Both are precision-engineered—each is designed to do a specific job faster . . . easier . . . at lower cost.

Further benefits of mechanized unloading are no less important. Operational hazards and injury possibilities are lessened. And you save demurrage charges. That's why—if your operations can be improved by rapid car unloading—it will pay you to get in touch with your nearest Link-Belt office.

LINK-BELT

CAR SHAKERS and ROTARY DUMPERS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 3,775



De Laval IMO rotary pumps can be furnished for almost any fluid handling problem in capacities to 750 gpm and pressures to 1,500 psig.

What to Look for in a Rotary Screw Type Pump

By W. J. MONCON, *Assistant Chief Engineer*
De Laval Steam Turbine Company

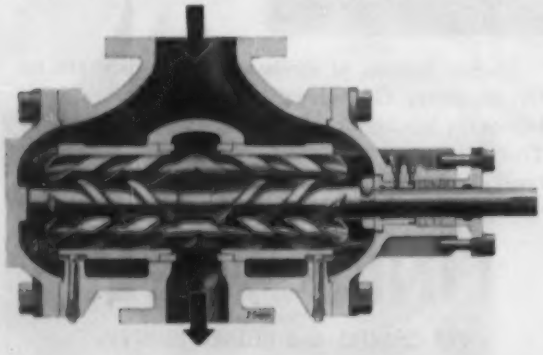
A sound knowledge of design, and how it affects performance, is the best insurance a buyer can have that he will get the pump he needs. This brief analysis of the IMO, a rotary three-screw pump manufactured by the De Laval Steam Turbine Company, will give you some of the necessary facts.

What qualities should you look for in a rotary type pump? It must, of course, meet specified capacities and pressures. But, it must also be efficient, operate quietly, stay on the job.

The axial flow of a screw type pump, and the resulting low inlet losses for any given pump speed, are important benefits that should be considered in making pump selections. The absence of timing gears and other mechanical features of construction also enable the De Laval IMO pump to operate at direct-connected motor and turbine speeds . . . to handle viscous liquids and high suction lifts.

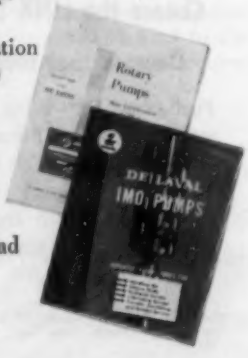
One of the most important features of the IMO pump is the hydraulic turning of the idler or sealing rotors. The central or power rotor is the pumping element; the liquid pumped turns the sealing rotors.

A screw type pump is well suited for applications where pulsation-free flow is desirable. The axial flow of the liquid without trapping and the unique thread form which keeps closures fluid-tight contribute to quiet operation of the IMO pump.



De Laval IMO Series A322A, a positive displacement, rotary screw type pump, can handle capacities to 750 gpm and pressures to 150 psig.

Catalog LS gives useful application and specification data on the IMO pump. An article titled, *Rotary Pumps, Basic Considerations in Their Application*, contains a description of rotary pumps in general. For these publications, write on your company letterhead to De Laval Steam Turbine Company, 815 Nottingham Way, Trenton 2, New Jersey. BL-301



Power

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DECEMBER 1955 POWER Vol 99—No. 12

POWER (with which are consolidated *Science and Industry, The Engineer Review, The Engineer, The Stationary Engineer* and *Operating Engineer*) is published monthly with an additional Handbook statistical number in September, by McGraw-Hill Publishing Company, Inc. James H McGraw (1860-1948), Founder.
PUBLICATION OFFICE: McGRAW-HILL BUILDING, 330 W. 42nd St., New York 36, N. Y.
EXECUTIVE, EDITORIAL and ADVERTISING OFFICES: 330 W 42nd St, New York 36, N. Y. Donald C McGraw, President; Paul Montgomery, Executive Vice-President; Joseph A Gerardi, Vice-President and Treasurer; John J Cooke, Secretary; Nelson Bond, Executive Vice-President, Publications Division; Ralph B Smith, Vice-President and Editorial Director; Joseph H Allen, Vice-President and Director of Advertising; J E Blackburn Jr, Vice-President and Director of Circulation.
SUBSCRIPTIONS: Address correspondence to POWER, Subscription Service, 330 W 42nd St, New York 36, N. Y. Allow one month for change of address. Subscriptions are solicited only from executives, engineers and supervisory personnel engaged in design, operation and maintenance of power, light, heat and other plant services in utilities, construction firms, industrial and service plants. Position and company connection must be indicated on subscription orders.
Single copies: U.S. and possessions, Canada 50¢ (except mid-September Handbook $1.00); all other countries $1.50. Subscription rates—U.S. and U.S. possessions: $4.00 for one year, $6.00 for two years, $8.00 for three years. Canada: $6.00 for one year, $9.00 for two years, $12.00 for three years. All other countries: $15.00 for one year, $25.00 for two years, $30.00 for three years. Second-class mail privileges authorized at New York, N. Y. Printed in U. S. A. Copyright 1955 by McGraw-Hill Publishing Company, Inc. All rights reserved.
POWER articles are indexed in both the *Industrial Arts Index* and the *Engineering Index*. POWER publishes its own annual index.

NUCLEAR ENERGY is fast moving into what we might call the "hardware" stage—we're building a variety of power reactors and getting ready to learn some lessons by operating them. Cover picture—the reactor cage for the Shippingport plant—typifies this step forward. Here's the heart of a 60,000-kw nuclear plant that will feed into Duquesne Light Co's system—that's getting to the hardware stage for sure.

For more details on the Shippingport plant, and the many other reactors on the boards or under construction, turn to p 73. There you'll find a 24-p special report summarizing the basic features of nuclear plants and rounding up the facts on units that will put these principles to work.

Next month . . .

Oxygen analysis. With today's trend to multi-fuel fired boilers, analyzing flue gas for CO_2 tells relatively little about combustion efficiency since CO_2 depends on fuel burned. But oxygen content of flue gas doesn't vary from fuel to fuel. So it's the most reliable index of combustion efficiency.

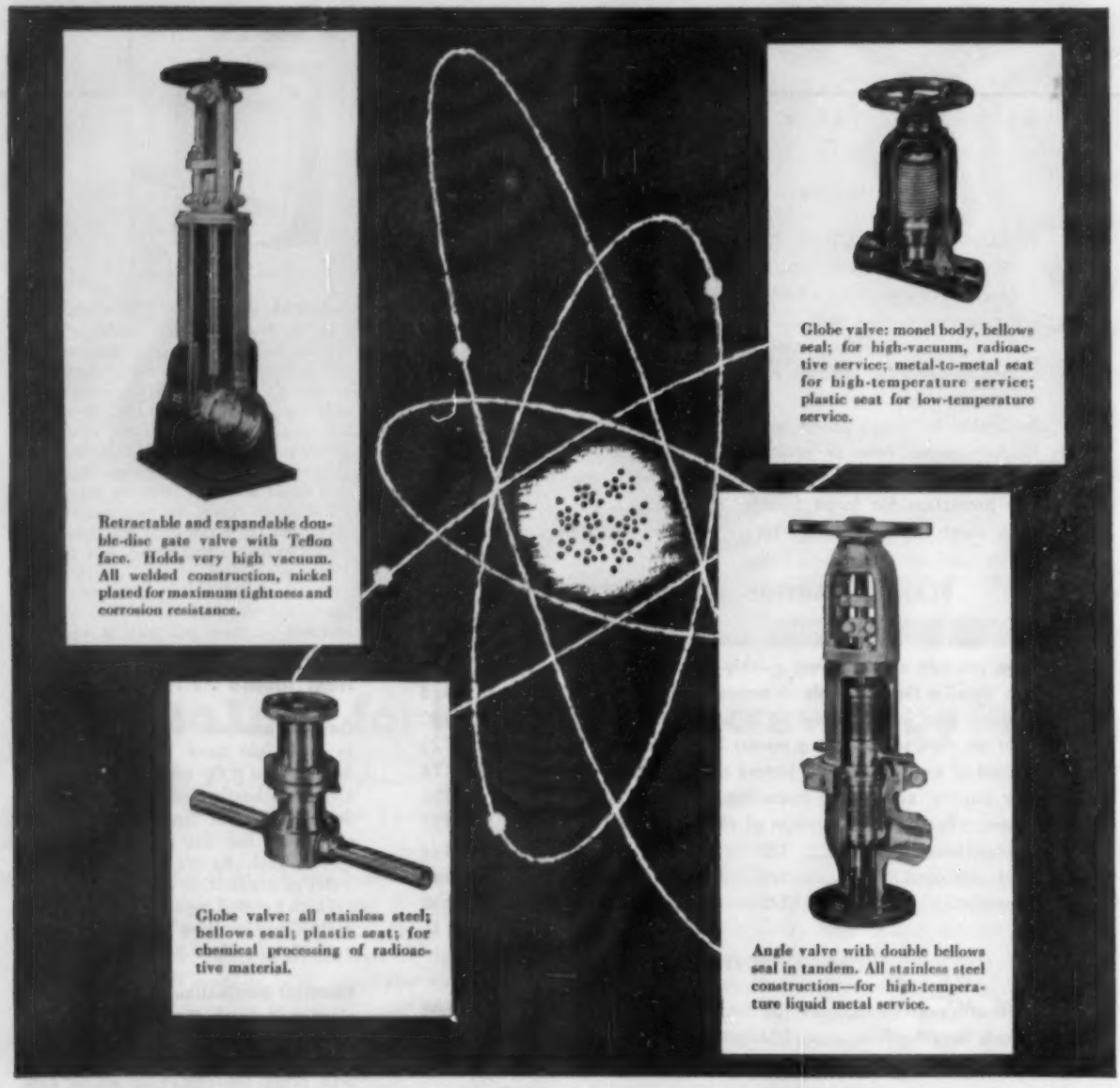
In an 8-p staff report you'll get highly useful info on how oxygen analyzers work and details of actual installations.

Electrical distribution. Ford's new auto plant at Mahwah, N. J. has latest power distribution system. In five pages, we'll spotlight important design features to help bring your thinking up to date.

Field-service engineer can be your best friend, as Merlyn E Norris, turbine engineer, tells us in a lively 3-page article. To show why, Norris gives a case history of old Bertha, a 40-year-old turbine with a checkered career. With machine manufacturer on one end of phone, field engineer has case histories, data, specialized experience to guide him. He can save your firm money, time.

. . . and future months

Mechanical Seals is the subject of our next practical manual—scheduled for March. Steve Elonka has talked with just about every major maker and user of seals, is now whipping into organized form a tremendous mass of info on how to select and use them.


Retractable and expandable double-disc gate valve with Teflon face. Holds very high vacuum. All welded construction, nickel plated for maximum tightness and corrosion resistance.
Globe valve: monel body, bellows seal; for high-vacuum, radioactive service; metal-to-metal seat for high-temperature service; plastic seat for low-temperature service.
Globe valve: all stainless steel; bellows seal; plastic seat; for chemical processing of radioactive material.
Angle valve with double bellows seal in tandem. All stainless steel construction—for high-temperature liquid metal service.

Flow control of Radioactive materials no problem for these Crane valves

Since the beginning of the AEC program, Crane, with gratifying results, has pitted its knowledge, resources and skill against problems in flow control that never before challenged man's ingenuity.

As a result of its experience, Crane now is producing valves that are used safely in the production of atomic material, and the use of it to produce power.

The four valves shown here are typical of valves now in active atomic energy service. They are, more than likely, prototypes of Crane valves you will need when *you* are ready to apply atomic energy to the production of power, or other processes involving radioactive material. Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Industrial Areas.

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VALVES • FITTINGS • PIPING
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CRANE'S FIRST CENTURY...1855-1955

speaking of **Power**

Editor Lou Rowley opens the first session . . .

. . . as executives discuss the impact of nuclear energy on the power field

Nuclear Energy Seminars—new dimension in industrial journalism

An impressive phrase—and one that was far from the minds of any of us when the idea for POWER's Nuclear Energy Seminars first popped up. We had been reviewing our editorial program in this actively growing field: the *Nuclear Energy Study Course* begun July 1954, the monthly *Nuclear Notes* page, the feature stories on new developments (Sept 1955, pp 75-81, for example), and what was then an upcoming special report for this issue.

Editors are never satisfied, but it did look as if we were reporting and interpreting this important development in a way that would fully meet the needs of our regular engineer readers. Before we could begin to feel good about the way our nuclear-energy editorial program was shaping up, somebody asked if this was enough. How about the makers of power-field equipment? What would the growth of nuclear energy mean to them in a business way? What new opportunities would it bring? What should they be doing about it?

The first step toward adding a new dimension to industrial journalism was then taken—when we saw the need for a new service to the management men of the manufacturers serving the power field. But a big question remained—what would be the best way to bring to these executives the basic information needed to assess the growth of nuclear power and grasp its future implications?

The Nuclear Energy Seminars are the answer. At these 2-day invitation meetings, POWER editors review the fundamentals of atomic energy, survey current developments and examine forecasts of nuclear development. This provides a basis for informal, down-to-earth discussion between editors and power-field executives, discussion aimed at appraising the impact of nuclear energy in our field.

Proof of the pudding came with the first seminar, held Oct 13 and 14 at the Hotel Pierre in New York (pictures above). It was a rewarding session for all concerned, and this experience was repeated Nov 29 and 30 in Chicago. Additional seminars are scheduled for the winter and early spring, in various parts of the country.

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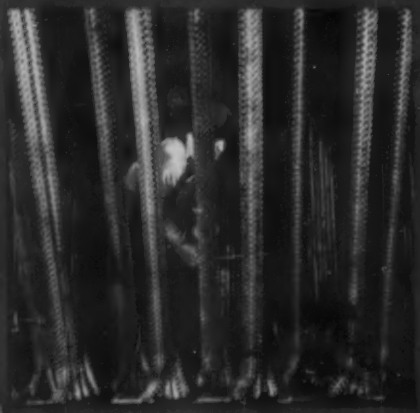
The pictures below show significant steps in the shop fabrication and assembly of B&W's Universal Pressure Steam Generator for Philo Plant.

B&W Universal

Assembly, complete and ready for shipment, of the second pass side wall is about 55 feet long, 5 feet, 6 inches wide. Alloy tubes are strength welded into the headers.

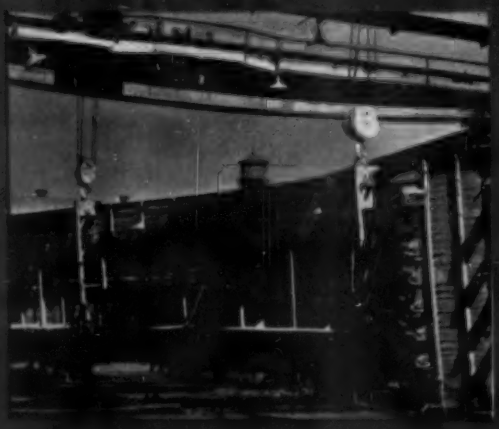
Floor tubes for secondary front wall assembly are carefully inspected for correct alignment.



An intricate job of bending, studding, and nesting characterizes the screen and floor for the secondary front wall.

Support castings being welded on flexible, small diameter tubes for roof assembly. Note that each tube end has a steel plug in it for cleanliness and future hydrostatic tests.

Shop assembly of secondary front wall. Note assembly frame which was made of plates and pipes welded together, but was not attached physically to the tube assembly at any point.



Secondary front wall section of alloy tubes and headers on its way to be completely stress relieved after assembly.

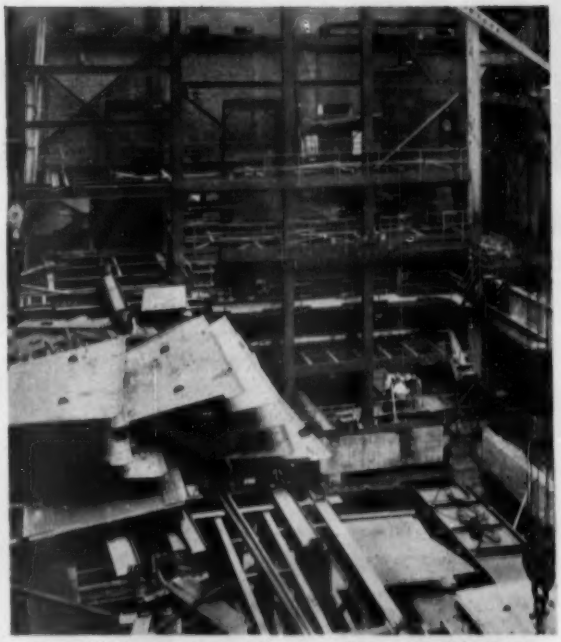
Pressure Steam Generator erection begins at Philo Plant

Final field erection has started on the world's first commercial supercritical pressure steam generator. At the Philo Plant of the Ohio Power Company, on the American Gas and Electric System, shop-assembled components of B&W's Universal Pressure Steam Generator are now being erected. It will supply steam at 4500 psi, 1150 F to a 125,000-kw turbine, and there will be two stages of reheat. Expected net heat rate is 8500 Btu per kilowatt hour.

The complete installation at Philo Plant represents a new break-through in steam electric generating efficiency. In the words of Phillip Sporn, President of American Gas and Electric Service Corp.:

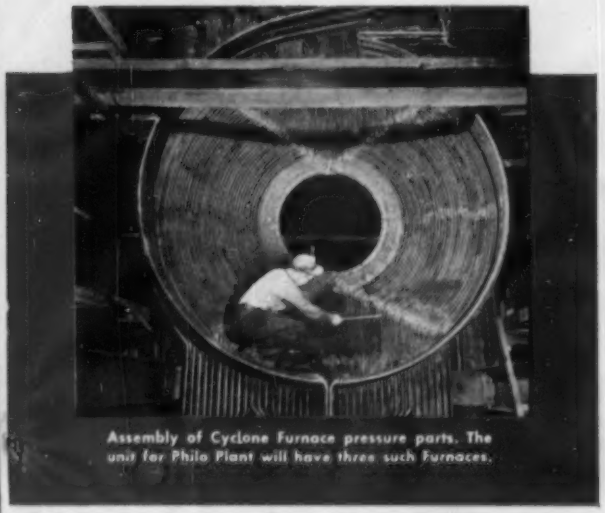
"The Philo project reflects the outstandingly dynamic character of the electric power industry. Here, in the very important field of energy generation, new frontiers are being pushed forward. Here, new avenues of approach to improvement in capital costs, in efficiency and in operating costs, are being opened. And, in keeping with the tradition that has characterized the growth and development of the industry, the results of this pioneering achievement will be made available to the rest of the industry.

"The electric power industry, far from challenging any particular method of generating energy, demonstrates by this Philo project its readiness to adopt and bring forward every new development that can advance its technical and economic well being."



Start of boiler erection at Ohio Power Company's Philo Plant.

Sectional View of B&W Universal Pressure Steam Generator.



Assembly of Cyclone Furnace pressure parts. The unit for Philo Plant will have three such Furnaces.

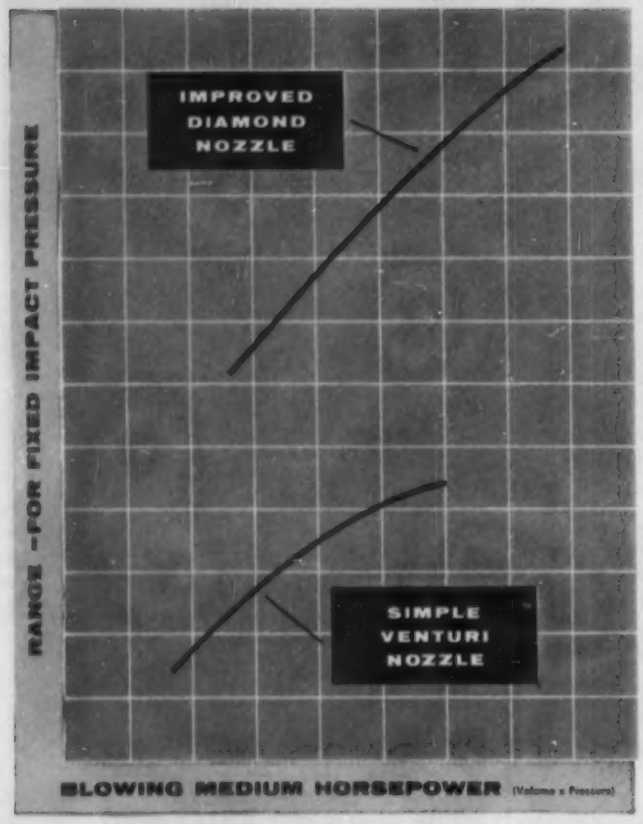
G-730

BABCOCK & WILCOX

BOILER DIVISION

GETTING BACK TO FUNDAMENTALS:

Efficient BOILER CLEANING


IMPROVED DIAMOND NOZZLE
SIMPLE VENTURI NOZZLE
RANGE —FOR FIXED IMPACT PRESSURE
BLOWING MEDIUM HORSEPOWER (Volume x Pressure)

The blower nozzle has the job of converting steam or air pressure into velocity which, in turn, produces impact pressure at the surface to be cleaned. Effective cleaning depends on this impact pressure. A well-designed nozzle will convert much more efficiently . . . doing a better cleaning job with less steam or air.

During the past several years Diamond has conducted intensive research into nozzle design to find the ultimate in efficiency. (More than 50 designs were tested.) It was soon found that nozzle design responds to perfection of detail. Among the details studied were: (1) divergence angle of nozzle, (2) inlet radius as a function of throat diameter, (3) length-diameter ratio of nozzle, (4) area ratio of lance to nozzle throat, and (5) nozzle approach conditions. A product of this research is our new "Type A" Nozzle for Model IK Blowers. The curves at the left show how much more efficient it is than the simple venturi nozzle. The result is improved cleaning at substantially lower energy cost.

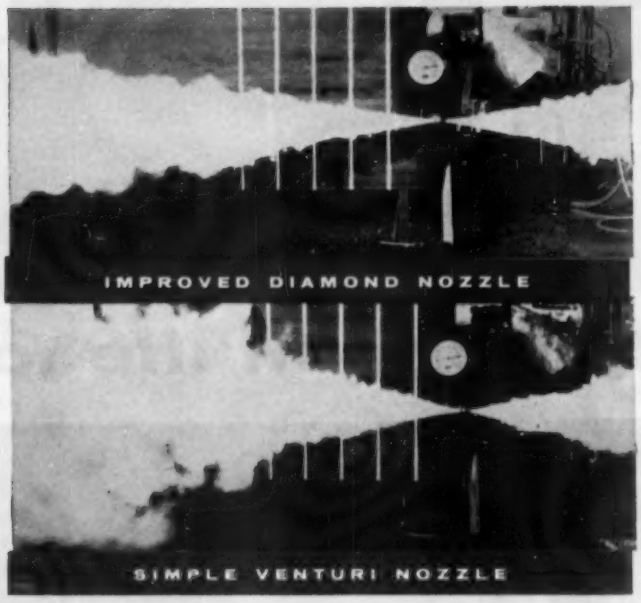
YOU CLEAN BOILERS *BETTER* and at *LOWER COST* with DIAMOND BLOWERS

DIAMOND MODEL IK LONG RETRACTING BLOWER

A SINGLE motor (air or electric) both rotates and propels the long lance tube through a simple and rugged gear system. Only one set of motor elements, one set of control elements and one set of power supply facilities to operate and maintain. Flow control of blowing medium (steam or air) is automatic, positive and accurate by means of a simple, mechanically operated valve. This valve is poppet type and has adjustable pressure control. The improved nozzle design coupled with the close helical cleaning pattern assures maximum effectiveness for each blower operating cycle. For additional advantages, write for Bulletin 1080U.

Starts at the BLOWER NOZZLE

Photograph of section through Diamond "Type A" Nozzle.

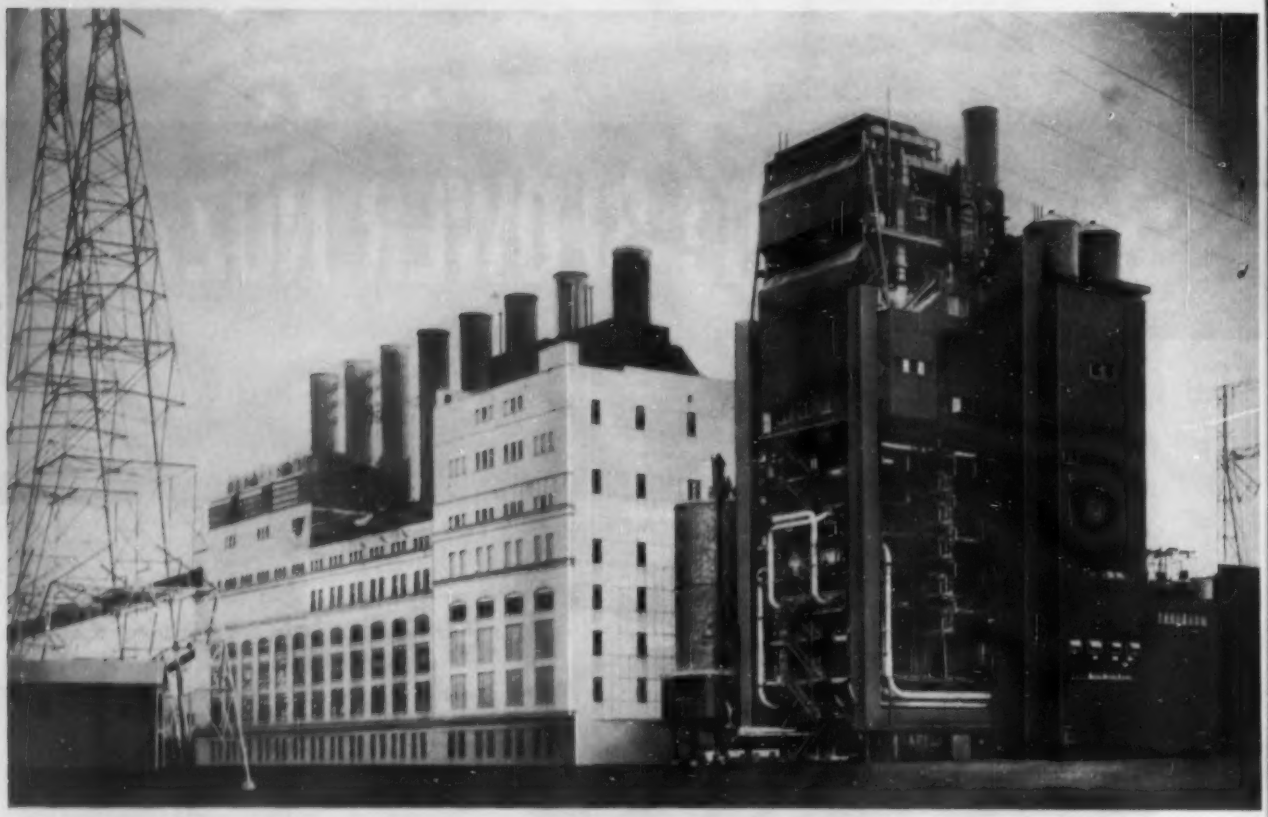


The two photographs at the left show the Improved Diamond Nozzle and the simple venturi nozzle under identical test conditions. These tests proved that the effective range of the new Diamond nozzle is substantially greater. Also that at the same range, the impact pressure of the Improved Diamond Nozzle is much higher than for the simple nozzle. For equal cleaning ability, the higher efficiency of the new Diamond nozzle requires a much lower blowing medium pressure.

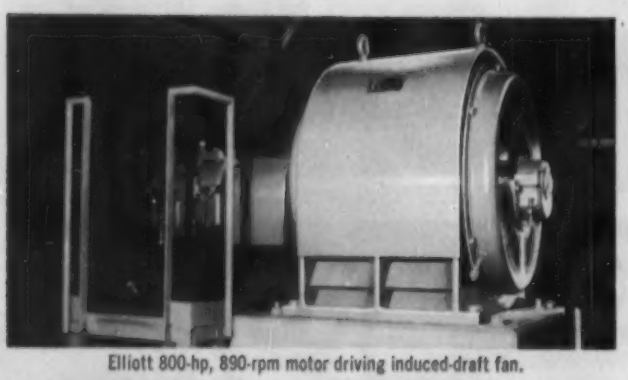
DIAMOND POWER SPECIALTY CORP.

LANCASTER, OHIO

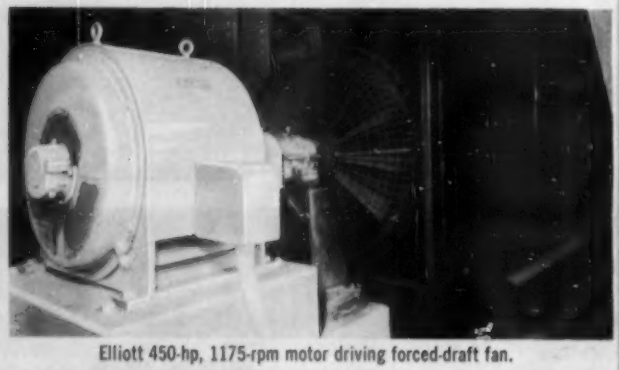
Diamond Specialty Limited • Windsor, Ontario



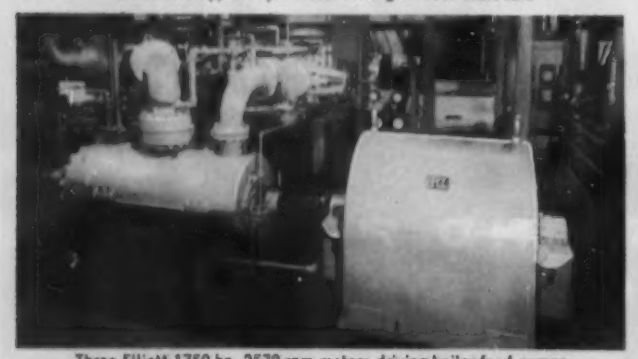
ELLIOTT equipment on the job



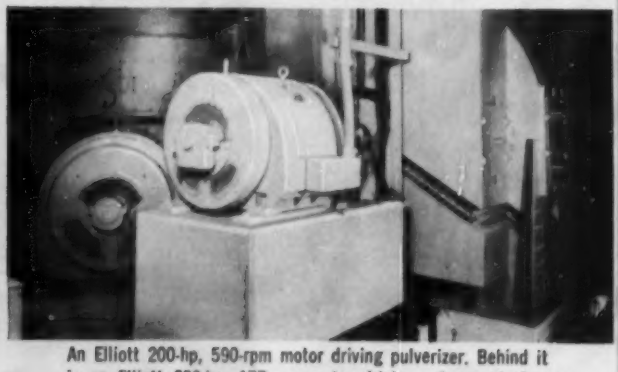
Elliott 800-hp, 890-rpm motor driving induced-draft fan.



Elliott 450-hp, 1175-rpm motor driving forced-draft fan.

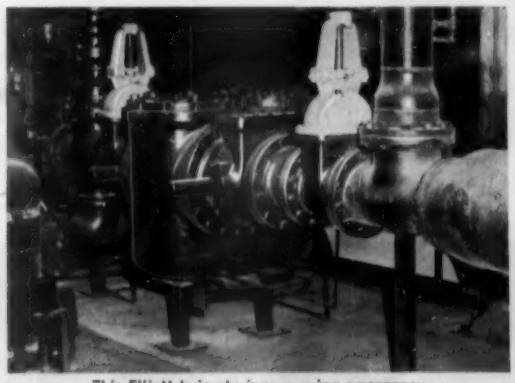


Three Elliott 1750-hp, 3570-rpm motors driving boiler-feed pumps.



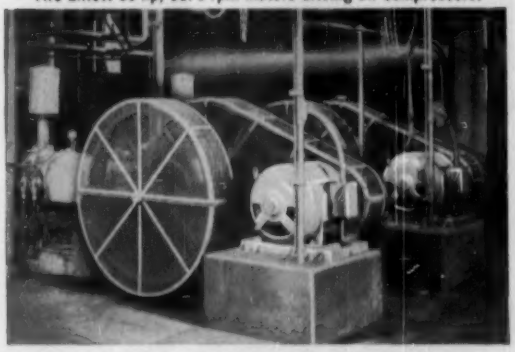
An Elliott 200-hp, 590-rpm motor driving pulverizer. Behind it is an Elliott 250-hp, 177-rpm motor driving primary air fan.

Elliott deaerating feedwater heater, rated 1,000,000 lb per hr, is installed outdoors.



This Elliott twin strainer, serving emergency fire water system, is also installed outdoors.

Two Elliott 50-hp, 1170-rpm motors driving air compressors.



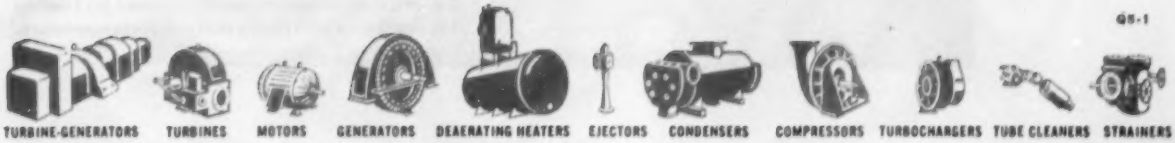
Springdale Station expands with new "outdoor" unit throughout modern addition!

● West Penn Power Company's Springdale Station has been steadily growing since it first went on the line in 1920. Since that time, new generating units have been added four times and the station has now been brought up to 450,000 kw to serve the growing Western Pennsylvania area. This latest addition—Unit Number Eight—has a capability of 140,000 kw and is an independent unit of semi-outdoor type construction. As is the case with the older units, Elliott equipment is found throughout the new addition. The deaerating heater, evaporator preheaters, twin strainers, and motors driving auxiliaries such as boiler-feed pumps, forced- and induced-draft fans, pulverizers and compressors all bear the Elliott nameplate.

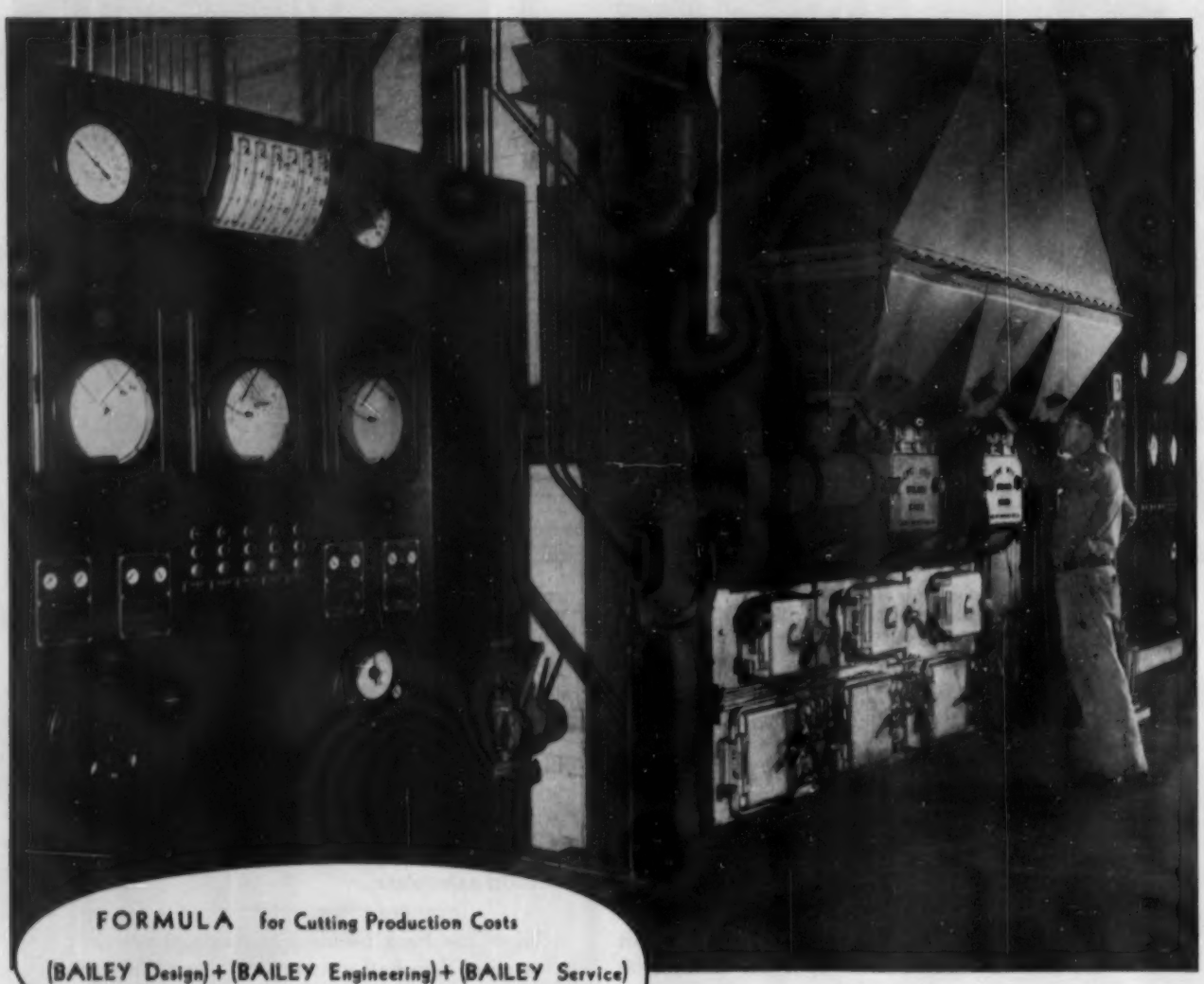
Elliott has been building power equipment for more than half a century. If expansion or modernization is in your picture today or tomorrow, it will pay you to investigate this equipment. Check with your Elliott District Office or write Elliott Company, Jeannette, Pa.

ELLIOTT Company

GS-1



How to Cut



FORMULA for Cutting Production Costs

(BAILEY Design) + (BAILEY Engineering) + (BAILEY Service)

= GREATER SAVINGS PER FUEL DOLLAR

At the heating plant of Lincoln Electric Co., Euclid, Ohio Bailey Control helps to cut operating costs by:

1. Controlling the rate of combustion in two spreader stoker-fired hot water boilers to maintain the desired temperature of outlet water.

2. Controlling fuel-air ratio at each boiler by means of a unique Btu-Air Flow meter which maintains most economical use of fuel.

3. Controlling quantity of water by-passed around boilers, thus tempering water supplied for heating in accordance with changes in outside temperature.

Operating Cost

★ When your plant is operating at peak efficiency, unit production costs are low. But outages of any kind upset the balance. As efficiency drops, and/or outages occur, overhead costs impose an increasing burden—bring on dollar losses that can't be recovered.

That's why you can use Bailey Co-ordinated Control Systems to advantage. Here are three reasons why Bailey systems are the best you can buy:

1. Complete Range of Equipment—fully co-ordinated

You need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment, just because he has a limited line to sell—or that Bailey will pass the buck for efficient control; we offer *complete* boiler control *systems.*

2. Engineering Service—backed by experience

No other manufacturer of instruments and controls can offer as broad an experience, based on successful installations involving all types of combustion, flow measurement, and automatic control.

3. Direct Sales-Service—conveniently located near you

Bailey Meter Company's sales service engineers are located in more industrial centers than those of any other manufacturer of boiler control systems; you get prompt, experienced service with a minimum of travel time and expense.

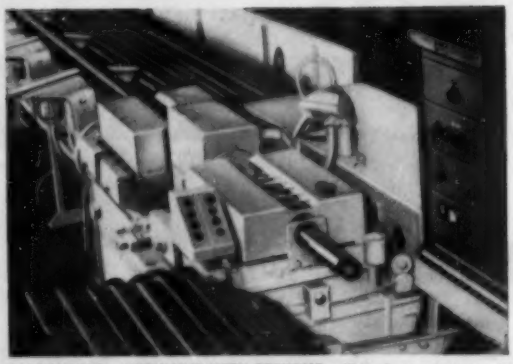
For lower operating cost—for more power per fuel dollar, less outage, and safer working conditions, you owe it to yourself to investigate Bailey Controls. Ask a Bailey Engineer to arrange a visit to a nearby Bailey installation. We're proud to stand on our record: "More Power To You!"

A-119A-2

BAILEY
METER COMPANY
1036 IVANHOE ROAD
CLEVELAND 10, OHIO
Complete Controls for Steam Plants

BAILEY METERS
Controls for
COMBUSTION
FEED WATER
TEMPERATURE
PRESSURE
LIQUID LEVEL
FEED PUMPS

QUALITY



FARROWTEST...EXCLUSIVE WITH REPUBLIC—This electronic tester is the most accurate non-destructive production testing equipment for tubing available today. Any flaw in the tube wall passing through the FARROWTESTER coils is registered by an oscillograph. In addition, the defect location is marked and the tube rejected.

...is much more than skin deep

Take an apple. It's a beauty. But if you peel it and find a worm hole, the beauty is stripped away just as surely as the peeling.

The old saying . . . "Beauty is more than skin deep" covers this situation. Further, if you take this saying and substitute "Quality" for "Beauty" you double its meaning. And considering the quality needed in boiler tubes to meet ever increasing pressures and temperatures, you can double the saying again. Allowable margin for error is practically zero.

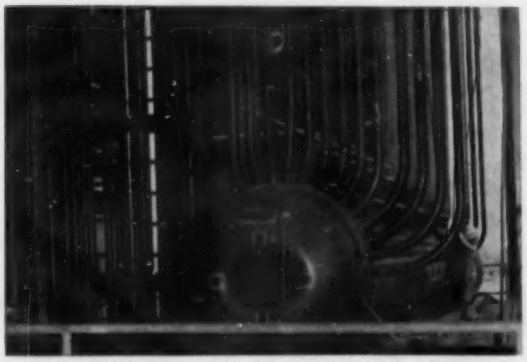
Quality has been the watchword in the manufacture of Republic ELECTRUNITE® Boiler Tubes, over the years. From raw ore to finished product, Republic exercises precise control over materials and methods. Then, completed ELECTRUNITE tubing is subjected to the most thorough testing program in the world. Of course this program includes the usual, and unusual, tests which take a sample and destroy it . . . to see what it can stand. But you can't put destroyed samples in service. What you need is a test that "gets under the skin" . . . so that you can be certain you receive the quality that was specified, and designed-in.

There is such a test today which Republic alone offers . . . an electronic test which shows up minute defects buried inside the tube walls. Its name . . . FARROWTEST® . . . developed by Republic to make certain that ELECTRUNITE tubing comes to you with the highest degree of perfection possible. You can specify this test on ELECTRUNITE Boiler Tubing instead of your present method, at no extra cost.

Millions of feet of FARROWTESTED ELECTRUNITE tubing are in service today in industrial, electric utility and marine boilers. Make sure you specify FARROWTEST on your next order for pressure tubing. Contact your Republic Steel and Tubes representative or mail the coupon for complete information. You'll be glad you did.

REPUBLIC STEEL

World's Widest Range of Standard Steels and Steel Products



QUALITY IS MORE THAN SKIN DEEP . . . but the skin is important, too. ELECTRUNITE Boiler Tubes are absolutely uniform in diameter and, through "controlled atmosphere" normalizing, clean, fine-grained and scale-free. Installation in boiler drums is fast . . . roll-in and beading easy . . . "weepers" minimized.

REPUBLIC STEEL CORPORATION
3144 East 45th Street
Cleveland 27, Ohio

REPUBLIC STEEL

Please send me more details on

☐ ELECTRUNITE Boiler Tubes

☐ FARROWTEST

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

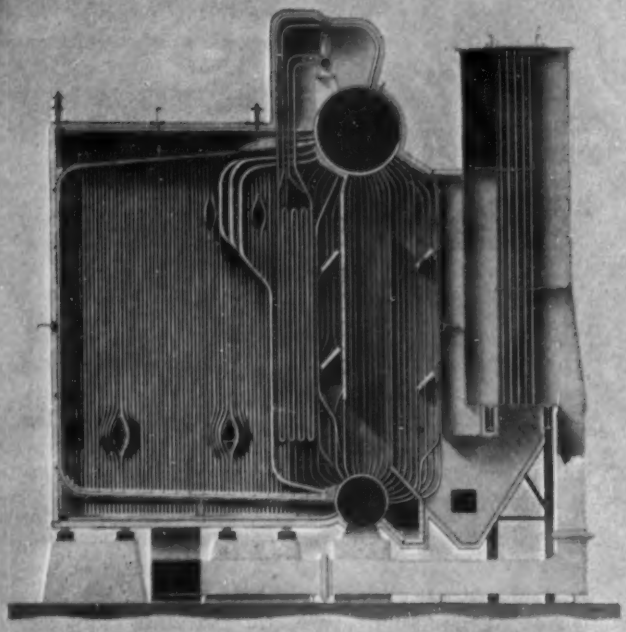
K 6012

one of these C-E standard boilers is....

DESIGNED FOR YOUR PLANT

If your steam needs range between 4,000 and 120,000 pounds per hour, one of these versatile C-E Boilers will give you economical, standout performance. For while they are standard in design (which means lower first cost and proven performance), they're still *flexible* enough to be easily adapted to your exact requirements.

Chances are that one of the C-E standard boilers is the answer to your steam needs. But whatever they may be, C-E can fill them. For C-E Boilers are made in sizes and types for *any* capacity—for *any* pressure—*any* fuel or method of firing.

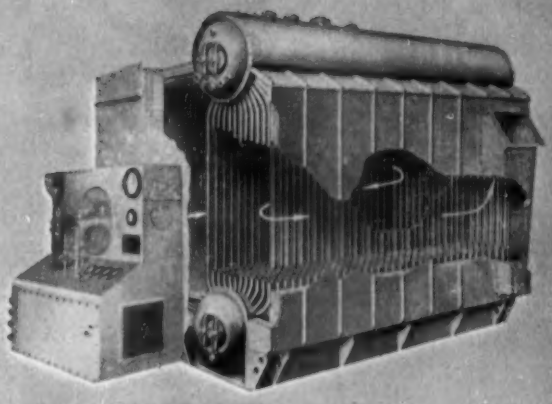


C-E Vertical Unit Boiler, Type VU-55

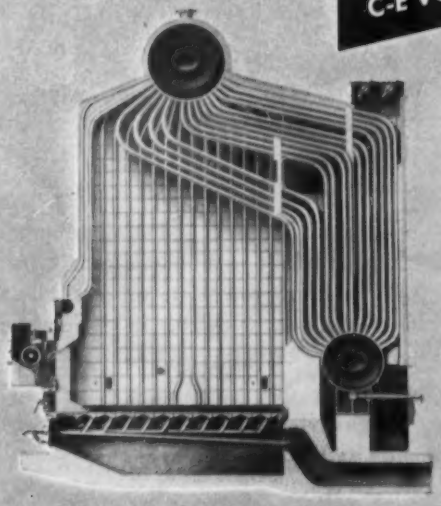
The VU-55 Boiler is available in six sizes ranging from 50,000 to 120,000 lb of steam per hr. It is designed for two pressure ranges—up to 250 psig and to 500 psig. These units are arranged for the application of superheater surface and heat recovery equipment if desired. VU-55 Boilers are designed for the pressure firing of oil or gaseous fuel and require no induced draft fan. They are equipped with tangential burners, tangent tube furnace walls and a double-wall, pressurized steel casing, to assure a level of performance which compares favorably with modern utility practice. The VU-55 Boiler is bottom supported requiring no supporting steel structure. The absence of exterior ductwork permits a smooth, streamlined exterior which is both attractive and practical.

C-E Package Boiler, Type VP

This completely shop-assembled boiler is available in fourteen sizes from 4,000 to 40,000 pounds of steam per hour... for operating pressures up to 500 psi..., for pressure firing of liquid or gaseous fuels. The VP Boiler has more water-cooled area per cubic foot of furnace volume than any other boiler of its size and type. The large lower drum—30-inch diameter—permits a simple, symmetrical tube arrangement... greater water storage capacity ... easy access for washing down or inspection. A centrifugal fan, which operates at low speed and is exceptionally quiet in operation, is standard equipment. The simple baffle arrangement results in low draft loss ... simple soot blowing ... no dead pockets ... high heat absorption. The VP is enclosed in a reinforced gastight, welded steel casing, and shipped completely assembled with firing equipment, fittings and forced draft fan. For foundation, it needs only a simple concrete slab.



C-E Vertical Unit Boiler, Type VU-10



The VU-10 is available in nine sizes from 10,000 to 60,000 pounds of steam per hour ... for operating pressures up to 475 psi ... superheat to 200° F in 20,000-60,000 lb range ... for solid, liquid, or gaseous fuels. This boiler is a completely standardized design adaptable to many conditions. It is bottom-supported and needs no outside supporting steel. It operates efficiently over a wide range of output, and is easy to operate and to maintain. All parts are easily accessible for inspection. The VU-10 is a complete unit—boiler, furnace, setting, fuel-burning equipment, controls, forced draft, heat recovery equipment (if desired). Regardless of fuel, the same general cross-sectional arrangement of drums, convection bank and furnace wall cooling is used. Uniform design through each transverse section assures even water level in the drum and uniform expansion.

A C-E Industrial Boiler for Every Need — Combustion Boilers are available in many other 2-drum designs — for capacities up to 350,000 pounds of steam per hour — and to burn any commercially available fuel. All of these boilers can be designed for use with pressures up to 1375 psi and steam temperatures as high as 960 F—utilize any type of steam recovery equipment—fit difficult space conditions. Let us give you full details on the complete line of C-E Industrial Boilers, including the C-E LaMont Controlled Circulation Hot Water Boilers.

B-8820

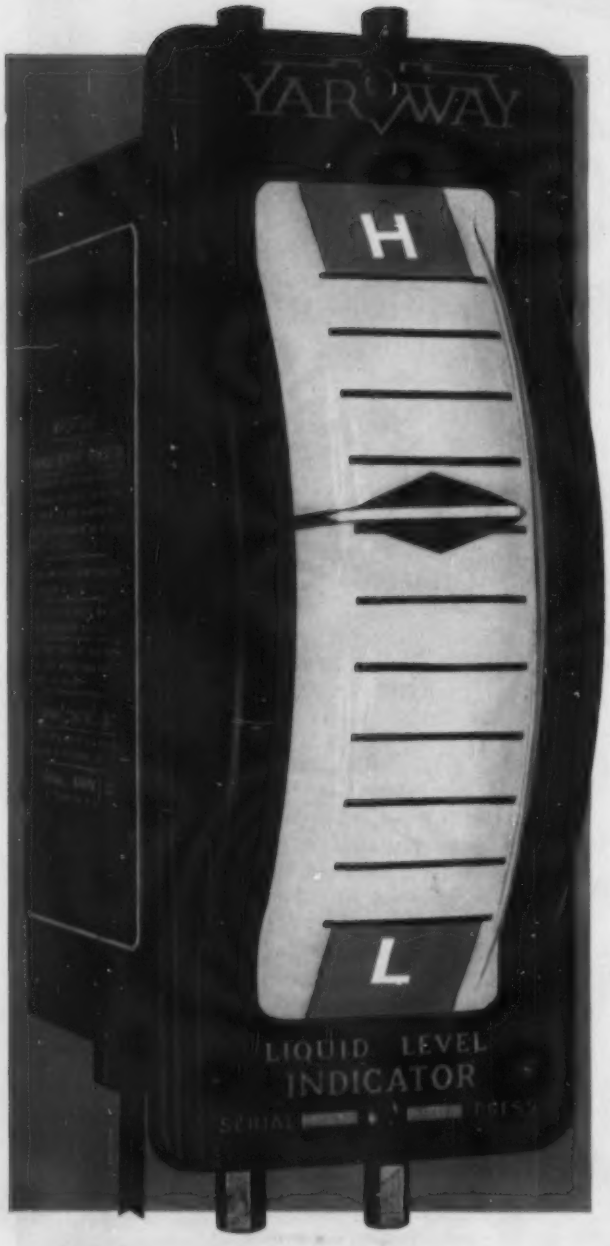
COMBUSTION ENGINEERING

Combustion Engineering Building, 200 Madison Avenue, New York 16, N. Y.

CANADA: COMBUSTION ENGINEERING-SUPERHEATER LTD.

STEAM GENERATING UNITS; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; DOMESTIC WATER HEATERS; SOIL PIPE

"this is



● Engineers tell us Yarway Remote Liquid Level Indicators are the most dependable boiler insurance they can have.

Instant . . . accurate . . . brilliant . . . continuous readings of boiler water level are seen on the panel or wherever you wish in your plant. You know the readings are right because they are controlled by the boiler water itself . . . by the pressure differential between a constant head of water and the varying head in the boiler drum. *Indicating mechanism is never under pressure.*

Yarway Indicators may be equipped with a Yarway Control Unit that operates Remote Hi-Lo-Alarm signal lights or horns. For a 24-hour record of boiler water levels, use the Yarway Hi-Lo-Graph Recorder.

On the boiler drum itself you'll want Yarway Water Gages . . . and these "bright as a star" gage readings can now be televised with a Yarway—RCA Television chain.

From drum to panel and at all remote locations, Yarway equipment gives you the safest boiler protection you can buy . . . proved beyond doubt in thousands of power plants.

Write for the specific bulletins you want.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

NEW! WIDER VISION!

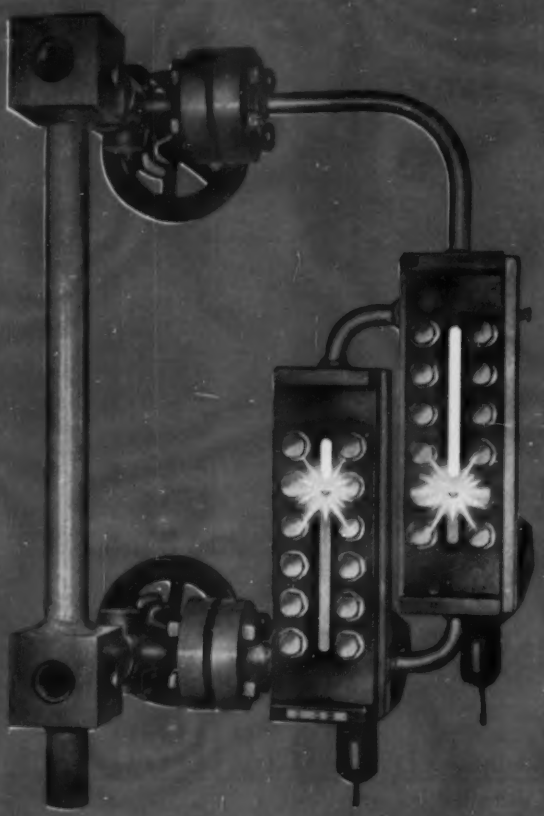
Clear, brilliant readings from any angle, are possible with the new "wide vision" face on the Yarway Remote Liquid Level Indicator. Pointer is always visible, even at extreme high and low water levels.

The Yarway Indicator is manometric type with automatic temperature compensation, as approved for use under the ruling of A.S.M.E. Boiler Code Committee in Case #1133.

Described in Yarway Bulletin WG-1824.

YARWAY

good boiler insurance!"



YARWAY WATER GAGES

Flat glass, high pressure type shown, features new separated-design insert and Type "M" illumination that causes water level meniscus to "shine like a star". Described in Yarway Bulletin WG-1812.

YARWAY REMOTE SIGNAL ALARMS

Lights on horns, operated by Control Unit on Yarway Indicator, give instant warning of any serious deviation from normal water level. Can be located anywhere in plant. Described in Yarway Bulletin WG-1824.

YARWAY HI-LO-GRAPH RECORDER

Gives a continuous 24-hour record of liquid levels. Actuating mechanism is same as in Yarway Indicator. Used both for indicating and recording. Described in Yarway Bulletin WG-1830.

YARWAY TELEVISION

Simplified system consists of compact camera and panel-mounted monitor. Clear, bright image of water level gage anywhere in the plant. Described in Yarway Bulletin WG-1818.

steam plant equipment

BLOW-OFF VALVES
WATER COLUMNS AND GAGES
LIQUID LEVEL INDICATORS
EXPANSION JOINTS
STEAM TRAPS
STRAINERS
SPRAY NOZZLES
DIGESTER VALVES

Photograph shows a section of the Langley-Bath Clearwater High School, located at Bath, Aiken County, S. C. It received design awards in the AASA-AIA School Building exhibition and the South Atlantic AIA Regional Honor Awards Program and from the School Executive magazine.

Lyles, Bissett, Carlisle & Wolff, architects.
E. M. Spong Construction Co., general contractor.
W. O. Blackstone & Company, plumbing and heating contractor.
All of Columbia, South Carolina.

YOUNGSTOWN PIPE installed in award-winning school

The planners of this school looked toward the future and specified pipe that will insure adequate protection to the radiant heating system for years to come. For years to come, because Youngstown Pipe is made only of the finest steel. Its quality is closely controlled from ore mine right through to the final threading operation.

The 7 points of uniform goodness in Youngstown Pipe add up to the fact that you can't go wrong with Youngstown. Be sure it is specified on your next order.

Having Problems?

For information and service, get in touch with the local distributor of Youngstown Steel Pipe—or phone our nearest District Sales Office.

7 reasons why YOUNGSTOWN PIPE was selected

1. Uniform Ductility
2. Uniform Lengths
3. Uniform Threading
4. Uniform Weldability
5. Uniform Wall Thickness and Size
6. Uniform Strength and Toughness
7. Uniform Roundness and Straightness

Youngstown

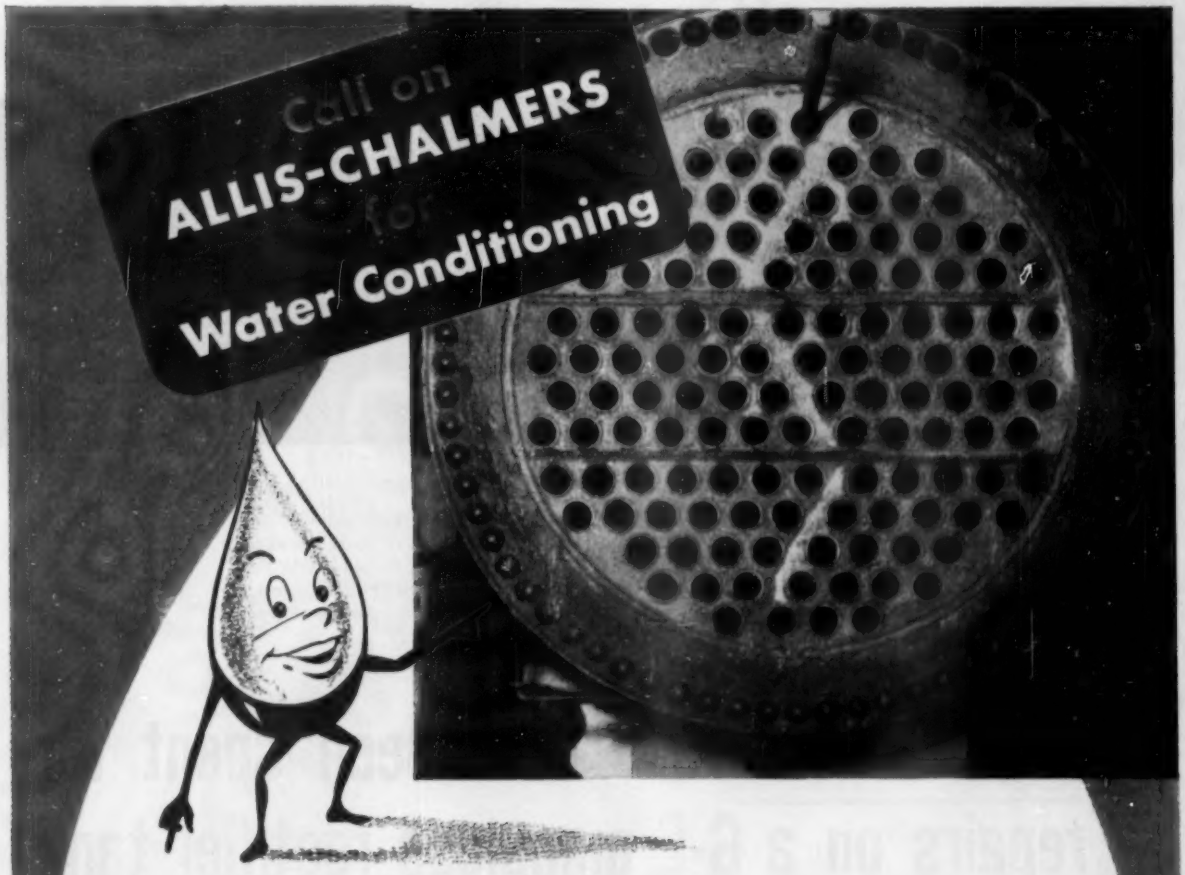
STEEL PIPE

QUALITY · YOUNGSTOWN · SERVICE

THE YOUNGSTOWN SHEET AND TUBE COMPANY *Manufacturers of Carbon, Alloy and Yoloy Steel*

General Offices Youngstown, Ohio District Sales Offices in Principal Cities.

SHEETS - STRIP - PLATES - STANDARD PIPE - LINE PIPE - OIL COUNTRY TUBULAR GOODS - CONDUIT AND EMT - MECHANICAL TUBING - COLD FINISHED BARS - HOT ROLLED BARS - WIRE - HOT ROLLED RODS - COKE TIN PLATE - ELECTROLYTIC TIN PLATE - BLACK PLATE - RAILROAD TRACK SPIKES - MINE ROOF BOLTS



12 MONTHS OF CONDENSER OPERATION AND . . .

Absolutely No Scale or Corrosion

Always before, every year, a heavy maintenance job. Until this year, that was the story of the horizontal ammonia condensers at the 4th Street Plant of Terminal Refrigerating and Warehousing Corp., Washington, D. C. Now Allis-Chalmers chemical treatment has provided a new picture, shown above.

You can see for yourself — there are no signs of scale or corrosion. There are scars from cleanings after previous years' operation because it used to be routine to find fairly heavy deposits partially plugging most of the tubes.

After complete analysis of both incoming water and operating conditions, Allis-Chalmers water conditioning engineers provided a recommendation that resulted in a vastly reduced maintenance problem for the plant engineer. A-C engineers also advised on efficient means for introducing the necessary chemicals into the system.

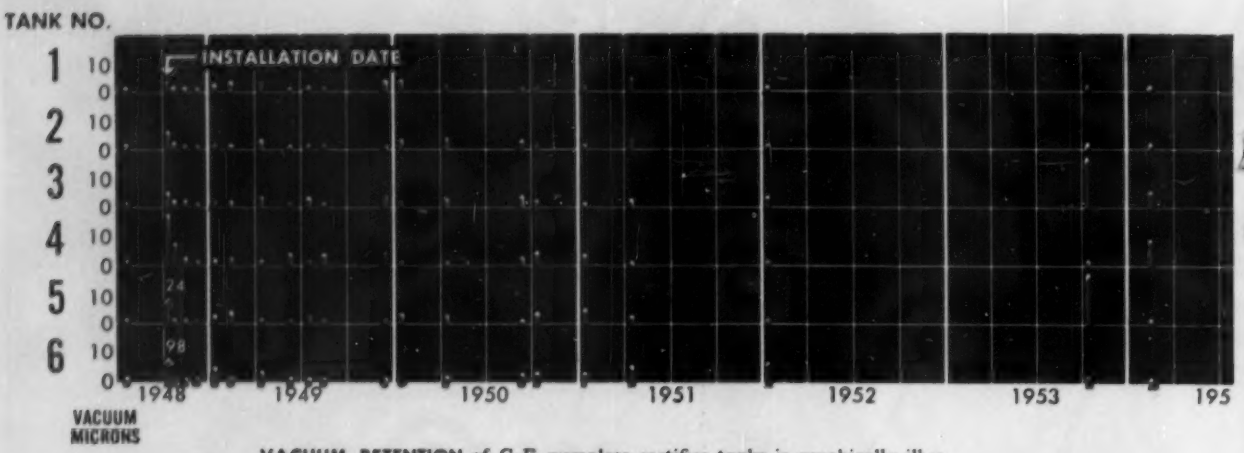
For your own water problems, it will pay to take advantage of Allis-Chalmers experience. Get more information — or a specific consultation on your problems — by calling your nearby A-C office. Or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

A-4823

ALLIS-CHALMERS

WATER CONDITIONING—CHEMICALS, EQUIPMENT, SERVICE—FOR OVER 25 YEARS

A-C ALLIS-CHALMERS



VACUUM RETENTION of G-E pumpless rectifier tanks is graphically illustrated here. None of these six tanks, installed almost seven years ago at the Buffalo plant of the Wickwire Spencer Steel Division of the Colorado Fuel and Iron Corporation, has ever required maintenance. This endurance test is conclusive proof that the G-E pumpless tank is an outstanding performer.

Not one cent has ever been spent for repairs on a G-E pumpless rectifier tank

Since 1948—when the first General Electric pumpless rectifier unit was installed—not a single customer anywhere in the country has paid out a penny for vacuum tank repair. And this is only a start. G-E engineers estimate a much longer life for this equipment. Here's why:

"PERMANENTLY-SEALED" TANKS, manufactured under almost antiseptic conditions, eliminate the need for a pumping system. This, in turn, eliminates such problems as mercury migration between tanks and the possibility of shutdown due to vacuum-system failure.

SUPERIOR MANUFACTURING AND TESTING methods have made this exclusive sealed-tank design possible. Tanks are assembled in a special air-conditioned room, then baked, pumped-down and sealed to assure the best possible vacuum. To check the possibility of even the most minute leak, tanks are pumped in a helium atmosphere and the exhaust is examined by a mass spectrometer leak detector capable of detecting one part of helium in 100,000 parts of normal air.

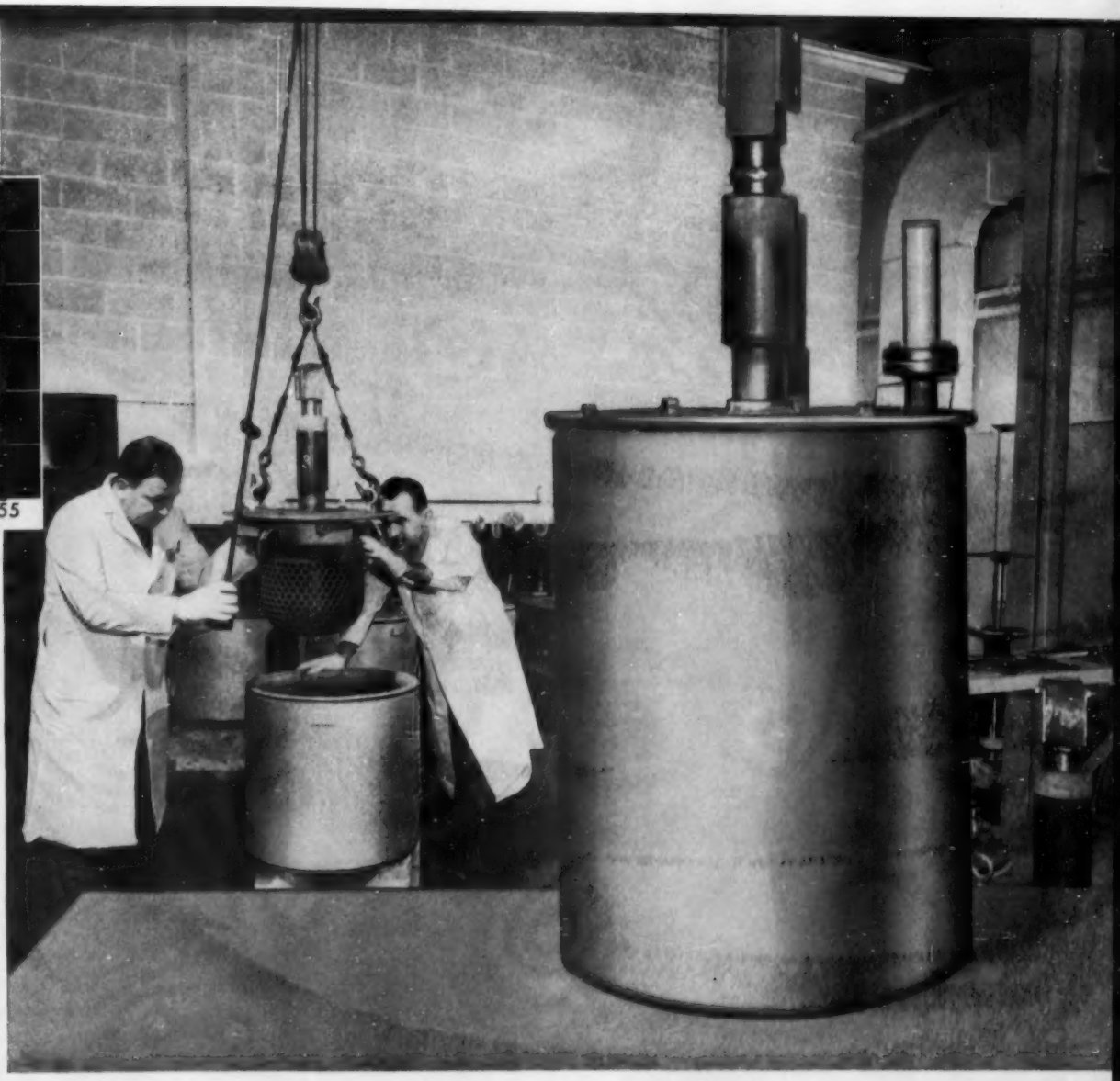
FACTORY RECONDITIONING of tanks, should it be necessary, is a relatively inexpensive process and relieves you of tank maintenance problems. The tank is reconditioned under the same controlled factory conditions described above and returned ready for more years of service. You can operate with a spare tank during reconditioning.

ADD TO THIS the highly efficient operation of mercury-arc conversion and you'll find that G-E pumpless rectifiers are the most economical way to get d-c power in the 750-kw range and above. For the whole story, contact your nearest G-E Apparatus Sales Representative or write for bulletin GEA-5689. General Electric Company, Schenectady 5, New York. 524-2

Progress Is Our Most Important Product

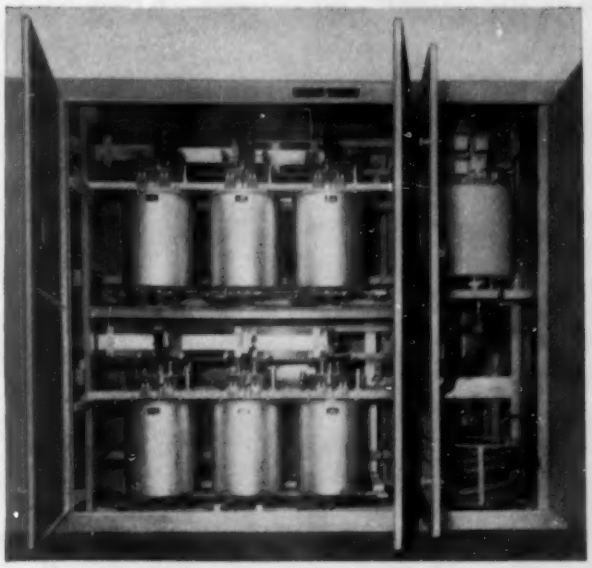
GENERAL ELECTRIC

4 1955



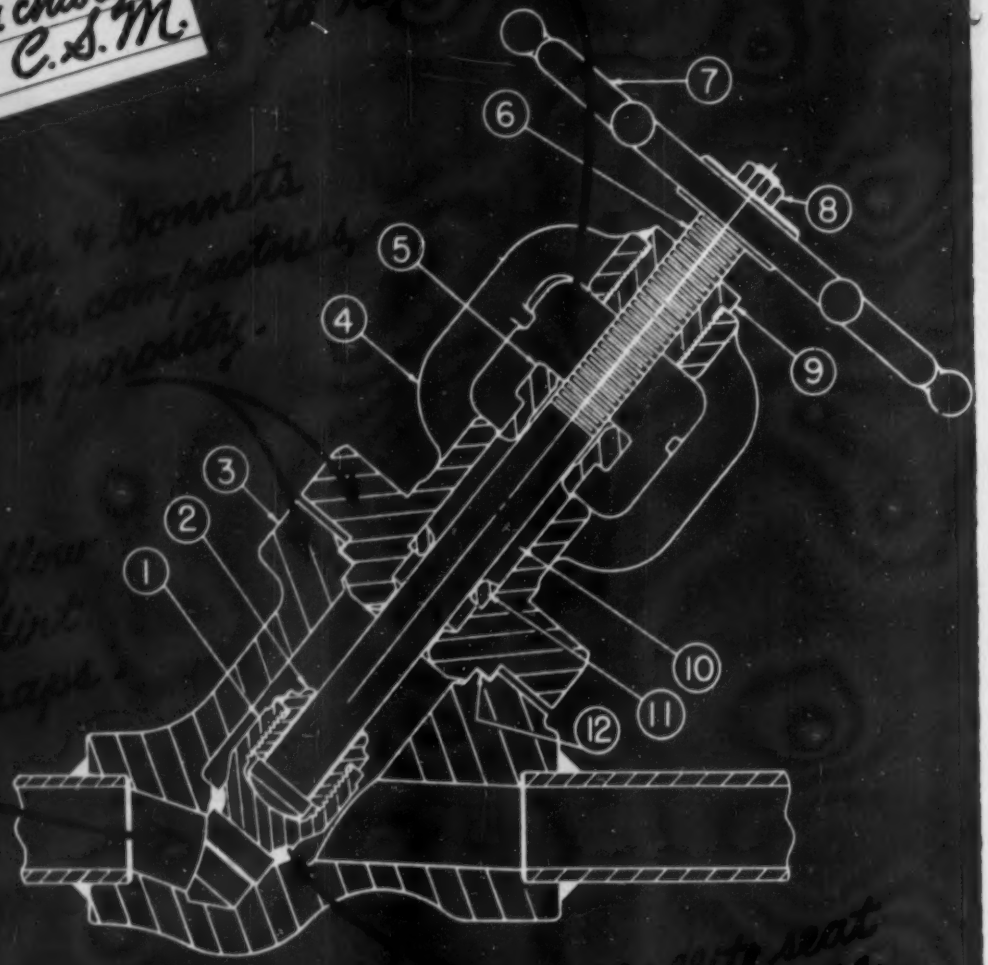
ASSEMBLY ROOM for pumpless-rectifier tanks is clean, air-conditioned to help prevent contamination. After assembly, testing with mass spectrometer leak detector assures that tanks are free from even the most minute leaks.

LONG LIFE AND LOW MAINTENANCE are the payoff when these tanks are put into service. The six-tank rectifier compartment shown here is furnished with transformer and associated a-c and d-c switchgear—a completely metal-enclosed d-c substation which requires a minimum of floor space.



GENERAL ELECTRIC

R. G. R.—
All boilermakers
Approve Edward
Blow-Off Valves—
will supply them
without extra charge.
C. S. M.



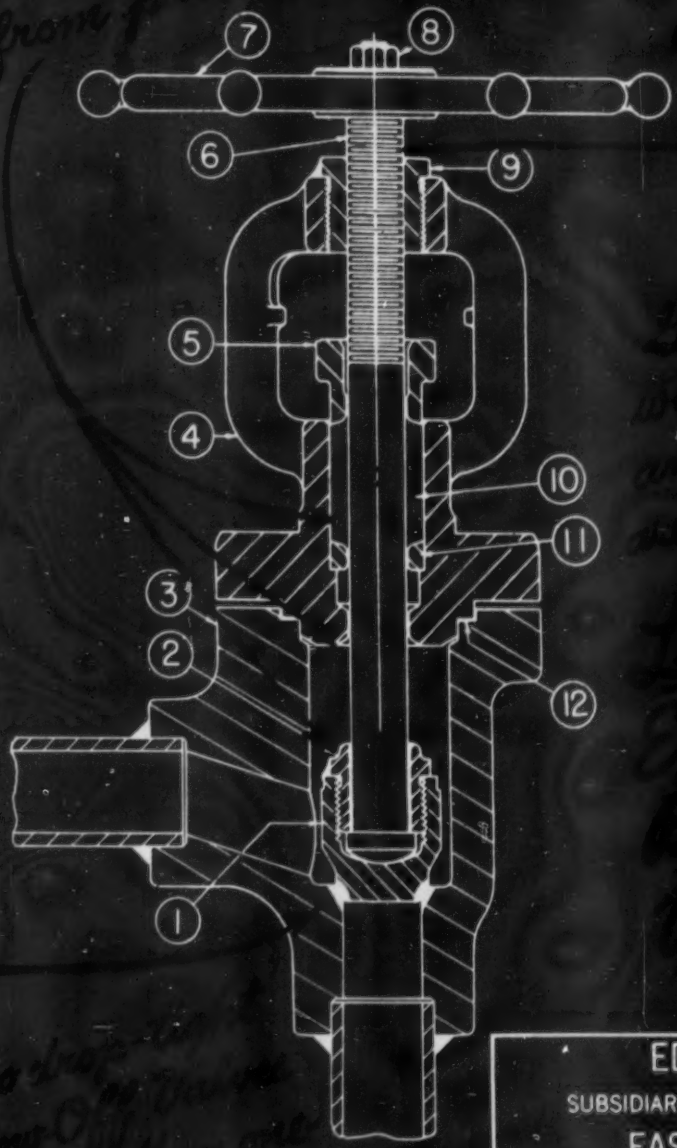
LIST OF MATERIAL

QUANTITIES ARE FOR 1 STRAIGHTWAY OR 1 ANGLE VALVE

WHERE A.S.T.M. SPECIFICATIONS ARE INDICATED THE LATEST REVISION APPLIES

PIECE NO.	NAME OF PIECE	NO. REQ'D	MATERIAL	SPECIFICATIONS	EDWARD MS NO.
1	DISK	1	FORGED ALLOY STEEL WITH STELLITED SEATING FACE	A.S.T.M. A182 GRADE F11	227
					485
2	DISK NUT	1	STEEL	A.I.S.I. C1120	123
3	BODY	1	FORGED STEEL	A.S.T.M. A105 GRADE II	111
			WITH STELLITED SEATING FACE		483
4	BONNET	1	FORGED STEEL	A.S.T.M. A105 GRADE II	111
5	GLAND	1	MALLEABLE IRON	A.S.T.M. A220, GRADE 53004	304
6	STEM	1	E-ALLOY	A.I.S.I. GRADE 416	261
7	HANDWHEEL	1	MALLEABLE IRON	A.S.T.M. A47 GRADE 32510	322
8	STEM NUT	1	STEEL	A.S.T.M. A194 - CLASS 1	124
9	YOKE BUSHING	1	BRONZE	A.S.T.M. B62	412
10	PACKING RINGS		EVALPAK	HIGH TEMPERATURE PACKING	501
11	JUNK RING	1	STEEL - EVALIZED	A.I.S.I. C1120	83
12	BONNET GASKET	1	RONKOTE	ARMCO IRON 90 BHN MAX.	505
13	GLAND BOLT WASHER	2	STEEL		
14	GLAND BOLT	2	FORGED STEEL EVALIZED	A.S.T.M. A105 GRADE II	111
15	GLAND BOLT NUT	2	STEEL - EVALIZED	A.S.T.M. A194 - CLASS D	125
16	TAP END STUD	4	ALLOY STEEL	A.S.T.M. A193 GRADE B7	208
17	BONNET STUD NUT	4	STEEL	A.S.T.M. A194 - CLASS 1	124

ROCKWELL-BUILT
EDWARD STEEL VALVES



EDWARD VALVES, INC.

SUBSIDIARY OF ROCKWELL MANUFACTURING CO.

EAST CHICAGO, INDIANA

1500 lb. FORGED STEEL BLOW-OFF VALVES

DRAWN Kalpakis		DRAWING No.
CHK'D. S Rust		AE-3664-1
APPD. D. Mathers	DATE 8-22-55	

Edward builds Globe and Angle Stop, Non-Return, Stop-Check, Check, Gate, Blow-Off, Mudline, Relief, Hydraulic, Instrument, Gage, and Special Valves and Strainers.

MOTOR FACTS ON INDUSTRY'S
MOST PREFERRED "POWER PACKAGE"

Electrical System Fact—Only the new Life-Line "A" motor gives you the unsurpassed corrosion-resistant protection of exclusive new Bondar, Bondite and Mylar* insulations.

*Du Pont Registered Trade-Mark

FACT:

The new Life-Line A is the most corrosion-resistant motor on the market

The corrosive action of chemicals takes a heavy toll on conventional motors. The new Westinghouse Life-Line® "A" motor offers more protection against corrosive atmospheres than any other motor you can buy. How?

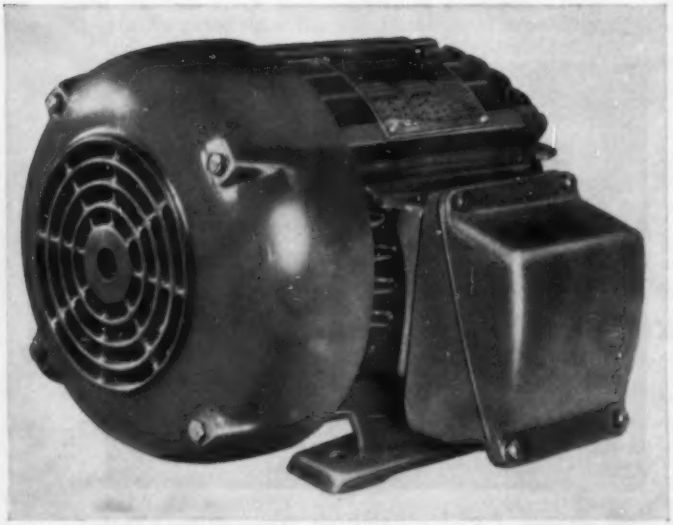
Because the combined improvements in insulation, housing and bearing design give unsurpassed protection against any contamination. It takes the right combination of such improvements in *all three systems*—electrical, mechanical and lubrication—to make the Life-Line "A" industry's most preferred power package.

Get all the facts by calling your Westinghouse sales engineer . . . *The Man With The Facts.*

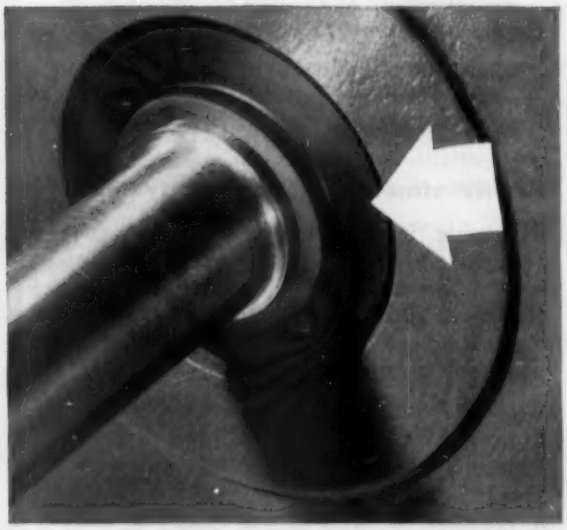
J-21881

YOU CAN BE **SURE**... IF IT'S

Westinghouse



Mechanical System Fact—New cast-iron frames and brackets utilize the finest grained castings with uniformly thick wall sections precisely fitted and sealed. Molded glass plastic cooling fans on totally-enclosed types are chemically inert.



Lubrication System Fact—The new pre-lubricated Life-Line "A" bearing features a "4-way seal"—*two* seals on each side. Totally-enclosed types have additional neoprene flinger which assures bearing protection in any corrosive application.

"Dated" instruments drain away dollars

Instruments can become outmoded . . . just like automobiles and ideas. Progressive instrument development is constantly making many older designs obsolete . . . and such obsolescence can be a steady drain on profits.

Modern instruments save money

Honeywell engineers are proving this fact every day—in a growing number of plants, on all types of processes. Where out-of-date controls have been replaced by modern Honeywell instrumentation, economy-minded engineers and management men have really opened their eyes. And with good reason, for—

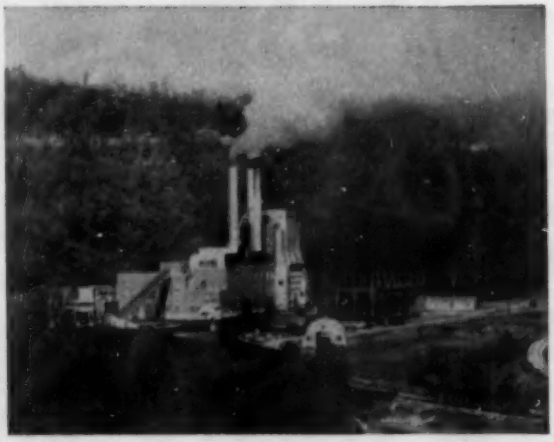
- Modern Honeywell instrumentation saves labor. Centralized control, automatic time-cycle systems, and other recent control concepts save countless wasted steps . . . reduce routine man-hour expenditures.
- Modern Honeywell instrumentation cuts maintenance costs. It affords longer, uninterrupted operation . . . is designed for easy service . . . requires minimum attention.
- Modern Honeywell instrumentation reduces rejects. It maintains the tighter process tolerances demanded by today's more exacting specifications.
- Modern Honeywell instrumentation improves product quality. Precision measurement and control remove any chance of error or guesswork in critical processes.
- Modern Honeywell instrumentation makes cost accounting more accurate than ever before. Everything is a matter of record.

An investment that really pays off

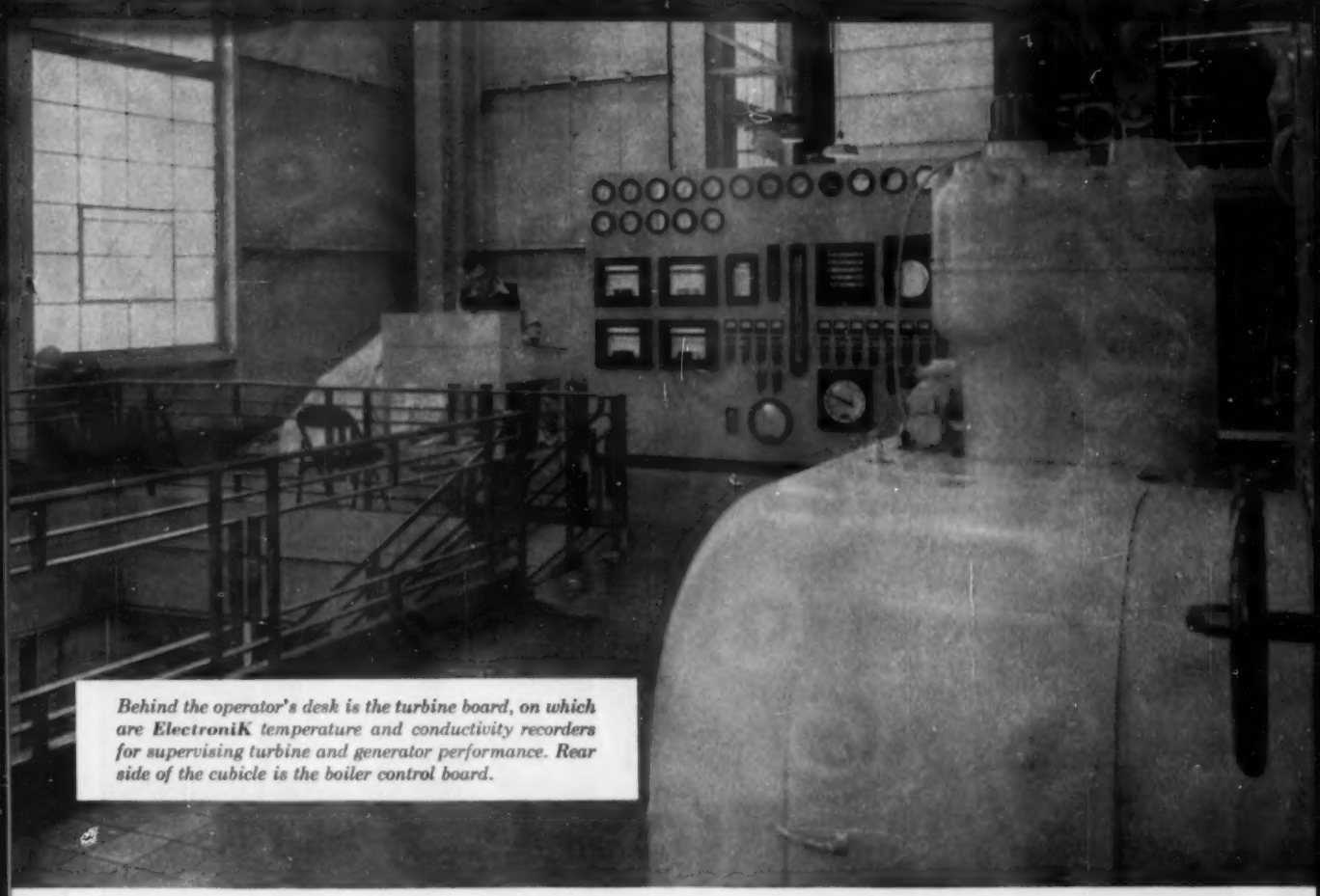
Just being "instrumented" is not enough. You can get more out of your instrument dollar, from both a product and service standpoint, with Honeywell instrumentation . . . the ultimate in engineering and design . . . insurance for your equipment investment.

Replacing with Honeywell is one of the best ways to invest your modernization appropriation. A Honeywell application engineer will gladly survey your present plant instrumentation . . . give you a practical recommendation that will make dollars and sense. Give him a call . . . he's as near as your phone.

Brown instruments supply vital data for operating 75-MW



General view of Kentucky Utilities' Tyrone Station. The 75-MW unit described here represents over half of the generating capacity of the station.



Behind the operator's desk is the turbine board, on which are ElectroniK temperature and conductivity recorders for supervising turbine and generator performance. Rear side of the cubicle is the boiler control board.

unit at Tyrone Station

MODERN INSTRUMENTATION TECHNIQUES have been utilized fully in the fourfold expansion that has taken place since the war in the total capability of the Kentucky Utilities Company. Typical of this trend is the control for the latest 75 megawatt unit added to the Tyrone Station (station design by Sargent & Lundy). The unit is equipped with comprehensive Honeywell instrumentation that gives operators centralized supervision of variables affecting safety of equipment and efficiency of output.

Boiler and turbine boards are mounted back-to-back on a single cubicle. On the turbine board are *ElectroniK* multi-point instruments which record temperatures of generator and turbine bearings, oil coolers, hydrogen coolers, condensate in hot well and heaters, and throttle steam. To keep watch on generator heating, an *ElectroniK* recorder charts temperatures at selected spots in the stator winding, and a single record instrument records rotor temperature. Another *ElectroniK* instrument provides a continuous check on condensate purity. All these instruments are equipped to actuate annunciators in the event that preset safe limits are reached.

Similarly, the boiler operating board includes *ElectroniK* instruments for recording steam conductivity as a means of preventing carryover and turbine damage . . . for checking heat-balance temperatures in preheaters, economizer, etc. . . . and for controlling recirculation of air through the preheater to guard against moisture condensation.

Your local Honeywell sales engineer will be glad to work with you and your consulting engineer on the application of this versatile line of instruments to your specific plant problems. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA:**
Write for Bulletin 90-2, "Supervisory Instruments for Power Generation."

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

First in Controls

JEFFREY car puller works in any direction . . .

370-45

Wherever a powerful, short-haul pulling force is required, a Jeffrey Car Puller works best.

At manufacturing plants it ends the delay of waiting for a yard locomotive to spot each car for loading or unloading. In some cases, it eliminates need for the locomotive. In others, it replaces the tiresome pinching process.

These "All Purpose" units are also used for docking barges, for handling moving operations in lumber yards, steel mills, brick plants and other industries. They are useful for many other applications.

- Large vertical capstan permits pulling in any direction.
- Compact design requires minimum space.
- Special attachment available to hold loads on grades.
- Forged car-pulling hook and single or double sheaves can be supplied.

Low initial cost, easy, push-button operation and minimum maintenance make Jeffrey Car Pullers pay for themselves many times over.

SPECIFICATIONS:

BASE — Heavy cast iron.

CAPSTAN — Chilled cast iron is standard and is for use with manila rope or Marlin clad steel rope. Cast steel can also be furnished for use with steel cable.

MOTOR — 5 H.P. on Type 240-A; 10 H.P. on Type 250-A. Motors are ball bearings, weather-proof and protected against overload. Control is by magnetic starter and weather-proof push-button.

GEARS — Hardened steel worm meshing with bronze worm gear.

BEARINGS — Slow speed capstan shaft is bronze bushed. Worm shaft is ball bearing equipped.

DRIVE — Cut tooth spur gear with micarta pinion direct connected to motor.

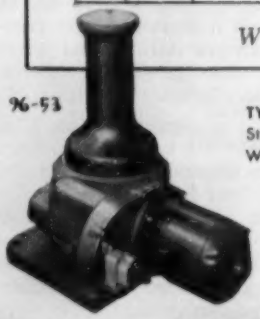
LUBRICATION — All working parts operate in an oil bath.

MAXIMUM ROPE SPEED — 45 F.P.M.

RECOMMENDED ROPE DIAMETERS

MANILA ROPE			MARLIN CLAD WIRE		
O.D.	Working Strength	Wt. Per Foot	O.D.	Working Strength	Wt. Per Foot
1⅛	2700	.42	13/16	4500	.51
1½	3700	.60	⅞	5700	.62
1⅝	4500	.75	1	7000	.81
1¾	5300	.90	1⅛	10000	1.10
2	6200	1.10			

Write for Bulletin 862.



96-53

TYPE 250-A
Starting rope pull: 10,000 lbs.
Weight: 1700 lbs.

TYPE 240-A
Starting rope pull: 5,000 lbs.
Weight: 800 lbs.

THE JEFFREY MANUFACTURING CO.

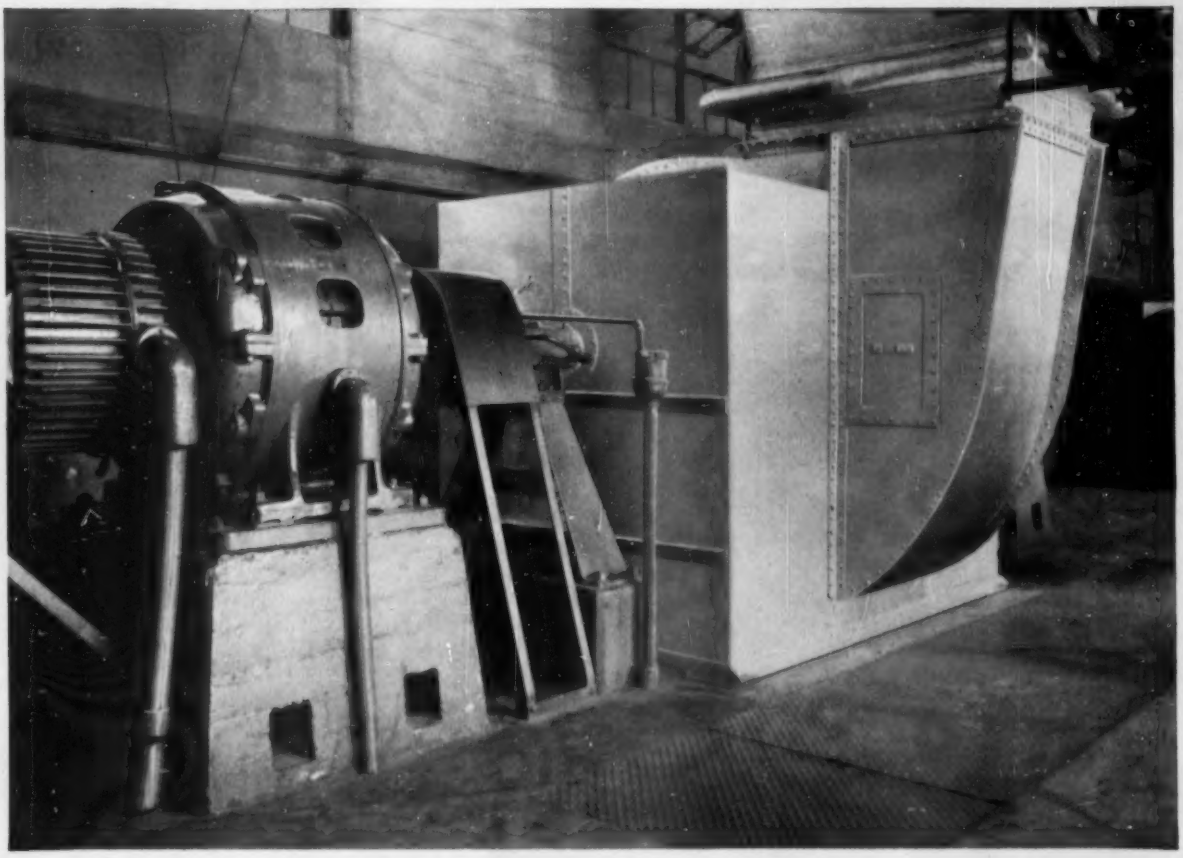
ESTABLISHED 1877

Columbus 16, Ohio

sales offices and distributors in principal cities

PLANTS IN CANADA, ENGLAND, SOUTH AFRICA

IF IT'S MINED, PROCESSED OR MOVED . . .IT'S A JOB FOR JEFFREY!



"Buffalo" Induced Draft Fan Installed in 1925

WHERE LONG-WINDEDNESS is a virtue!

The place where long-windedness is a prime virtue is in your boiler draft equipment. While the everlasting draft fan is yet to be invented, it is certainly true that the *longer* a fan can stand up under the beating of draft service, the more money you're saving.

That's why we've always concentrated on building long life into "Buffalo" Fans. Consider these "Q" Factor* features that explain the number of 30-year "Buffalo" Fans still on the job:

- Heavy steel plate blade and housing construction to stand heat and erosion.
- Low rotor scrubbing velocities, due to efficient modified backward curved blades.
- Strong rotor with stiff center plate — massive hub.
- Oversize alloy steel shafts with integral thrust collars.
- Low bearing pressure and large oil reservoir.
- Quick-opening access doors and removable bolted, sectional housing.
- Stable performance under widely varying load conditions.

The "Buffalo" Draft Fan you buy today embodies the finest and latest features for long life, performance and economical maintenance developed in our 78 years. It will pay you to write for Bulletin 3750 today and get all the facts.

**The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.*

"Buffalo"

BUFFALO FORGE COMPANY

488 BROADWAY BUFFALO, N. Y.

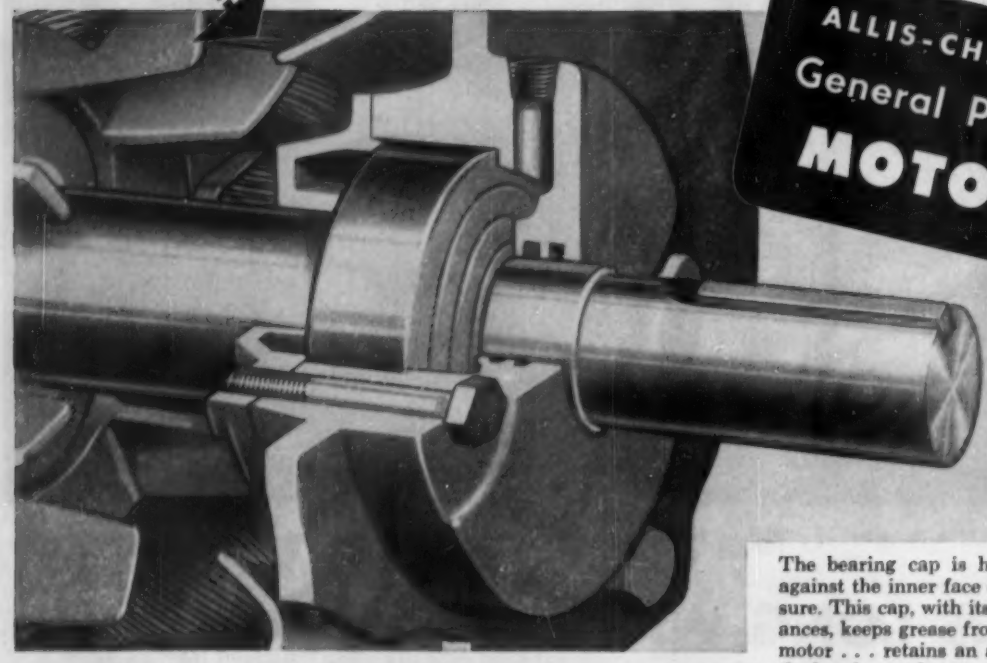
PUBLISHERS OF "FAN ENGINEERING" HANDBOOK

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

Sales Representatives in all Principal Cities

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING

Get Both
bearing features



The bearing cap is held tightly in place against the inner face of the bearing enclosure. This cap, with its close running clearances, keeps grease from the interior of the motor . . . retains an ample supply within the bearing enclosure . . . protects the grease and the bearing against contamination from dirt and moisture.

At the outer side of the bearing, double labyrinth seals keep grease in, also keep dirt out. What's more, large grease reservoirs act as additional dirt traps.

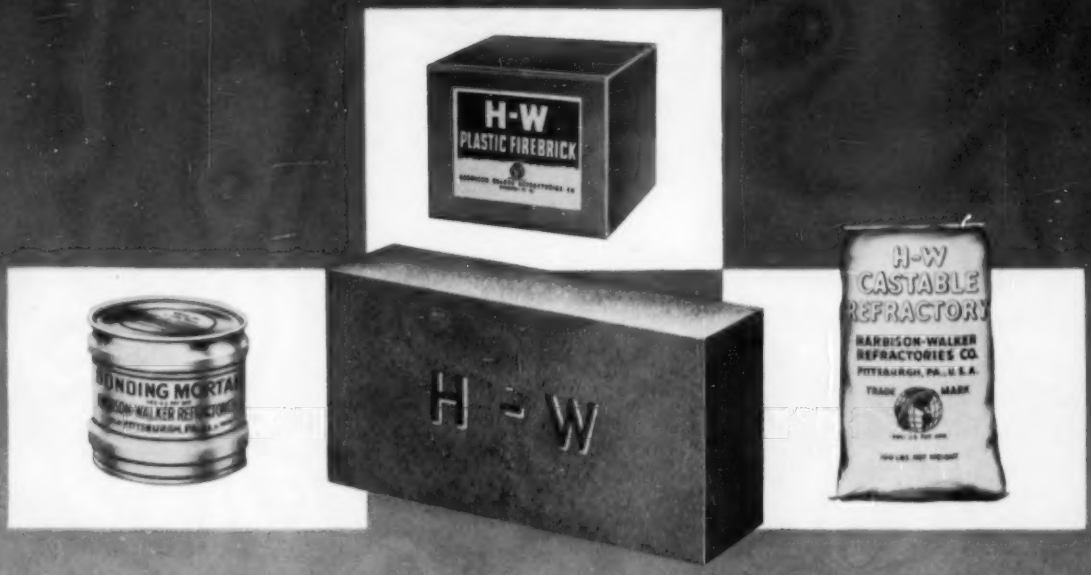
fully enclosed and protected
. . . yet
easy to grease

You can lubricate the bearings without dismantling the motor. Pipe-tapped holes in the bearing housings at two points provide both means for inserting new grease and a means of flushing out old grease.

Look for the extra bolts on the end housing . . . the sign of greater value. Ask your Allis-Chalmers representative or Authorized Distributor to show you a cutaway section of this maintenance-cutting design. Or write Allis-Chalmers, Milwaukee 1, Wisconsin, for Bulletin 51B6210.

A-4608

ALLIS-CHALMERS



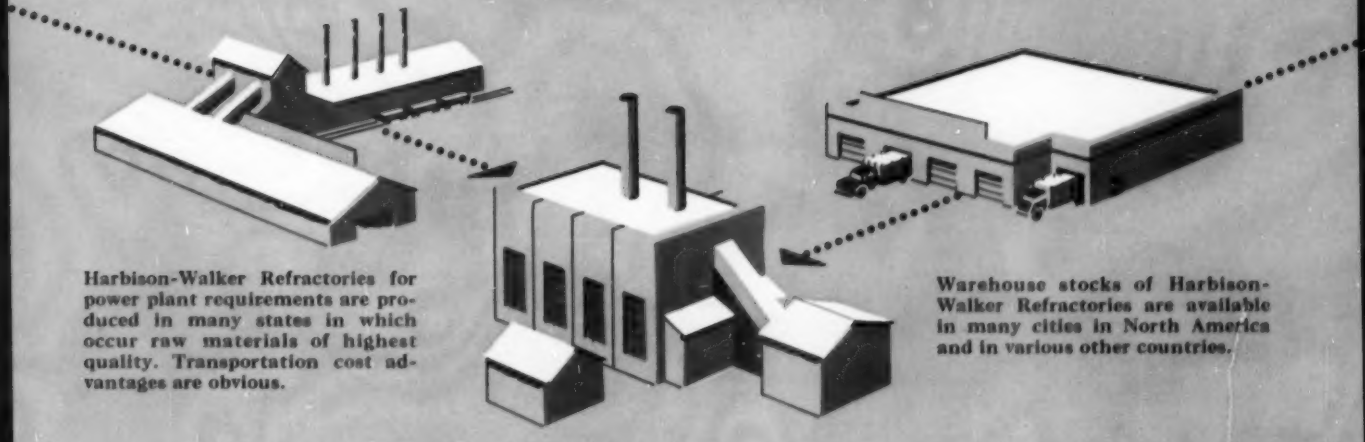
HARBISON-WALKER

REFRACTORIES

for every type of boiler furnace . . .

for every fuel . . .

AVAILABLE NEARBY



Harbison-Walker Refractories for power plant requirements are produced in many states in which occur raw materials of highest quality. Transportation cost advantages are obvious.

Warehouse stocks of Harbison-Walker Refractories are available in many cities in North America and in various other countries.

REFRACTORIES FOR ALL REQUIREMENTS. To meet the wide variety of operating conditions that exist in steam power generating plants, Harbison-Walker provides a complete line of refractories from which can be selected the exact types and brands for the most economical service.

Continued next page

You can secure maximum economy

by using HARBISON-WALKER

REFRACTORIES

Harbison-Walker products include the many different kinds of refractories needed in boiler settings of every type and for all fuels and firing practices. These provide the kinds of refractories that give maximum service with best economy in each particular application.

Harbison-Walker Refractories are used to advantage in industrial and commercial plants, as well as in central power stations. Listed below are the principal types and classes of refractory products which are regularly used for boiler plant requirements.

Technical service based on the most extensive experience and research is freely offered for assistance in determining the refractories best suited for each specific requirement.

A Complete Line of Highest Quality Products

REFRACTORY BRICK

The various brands of Harbison-Walker refractory brick used for walls, bottoms, arches, stacks, ash pits and other service comprise all classes of fireclay and high-alumina refractories. Included in the full complement of products are all the different kinds of basic and silica brick.

PLASTIC REFRACTORIES

Harbison-Walker plastic refractories are widely used for the construction of arches, target walls, baffle walls, burner ports and irregular shapes, as well as for making quick and economical repairs. These plastic refractories are made in both standard and super-duty classes. They are easy to install with the various H-W anchors and form durable, one-piece structures. Plastic Thermolith Batch is a chrome refractory and because of its chemical composition and dense impervious texture when heated, gives outstanding service in bottoms of slag-tap boiler furnaces.

CASTABLE REFRACTORIES

The development of castable refractories in a dozen specialized classes has resulted in noteworthy economies in the construction of furnace linings of irregular design and in the forming of difficult special shapes. They are shipped in dry form and when mixed with water like concrete may be poured, tamped into place or applied by means of air placement guns.

Among the various kinds of Harbison-Walker castable refractories used in boiler plants are: standard and super-duty grades, extra strength, high alumina, chrome, and lightweight classes as well as baffle mix. The wide variety of these specialized castables provides for every particular need.

INSULATING REFRACTORIES

Harbison-Walker insulating fire brick are made in seven brands, each of which is suitable for use over specific temperature ranges. Used as backing for the dense refractories which are required to withstand extremely severe treatment, they conserve heat and reduce the weight of the furnace lining. In addition to the conventional and special brick shapes, Harbison-Walker insulating refractories are available in the form of lightweight castables, block insulation and mineral fiber coating material.

MORTARS

The bonding mortars for boiler furnace requirements should be selected as carefully as the refractories with which they are used. The choice depends upon the kind of refractory and the service conditions. Harbison-Walker produces both hot and cold-setting mortars of various compositions having special characteristics for specific applications. Harwaco Mastic is a specialized product having a consistency similar to stiff putty which makes it ideally suited for plastering with a trowel as for example, in sealing the V-shaped spaces at the exterior face of tangential tubes in water-wall boilers.

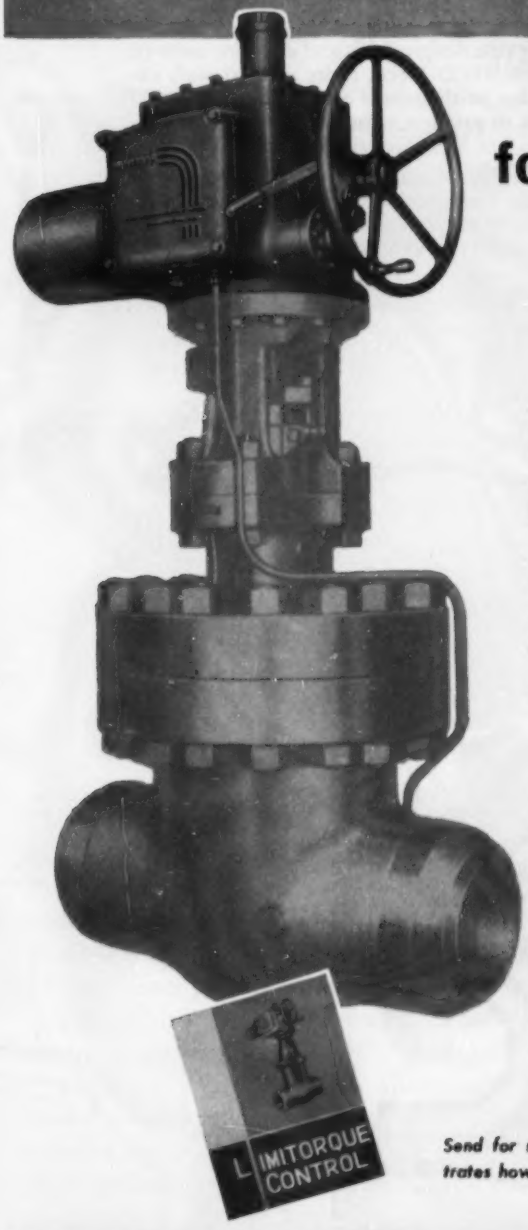
See other side

HARBISON-WALKER REFRACTORIES COMPANY
AND SUBSIDIARIES
World's Largest Producer of Refractories
GENERAL OFFICES: PITTSBURGH 22, PENNSYLVANIA

YOU CAN ALWAYS COUNT ON

Limitorque®

for Push-Button Operation of VALVES



LimiTorque operates at the mere push of a button—saving time, labor, and money—over manual operation of valves at distant or inaccessible locations. LimiTorque opens and closes valves at the exact speed required, and "limits the torque" applied to valve operating parts, thereby preventing possible damage to valve stems, seats and discs. For safety, the handwheel "cannot rotate" when the valve is being motor operated.

LimiTorque may be actuated by any available power source—Electricity, Steam, Oil, Gas, Water or Air—and is now available for Microwave control.

You take no chances with LimiTorque, because these units have been time-tried and tested under the most severe operating conditions for more than 15 years. LimiTorque meets the demands of modern industry for the very best in Automatic Valve Operation.

Send for new Catalog L-550, which describes and illustrates how and where LimiTorque is used on land and sea.

PHILADELPHIA GEAR WORKS, INC.

ERIE AVE. & G ST., PHILADELPHIA 34, PA.
NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA.
BALTIMORE • CLEVELAND
LimiTorque Corporation-Phila.

Industrial Gears & Speed Reducers

LimiTorque Valve Controls
Established 1892

Guaranteed TO SHUT TIGHT*

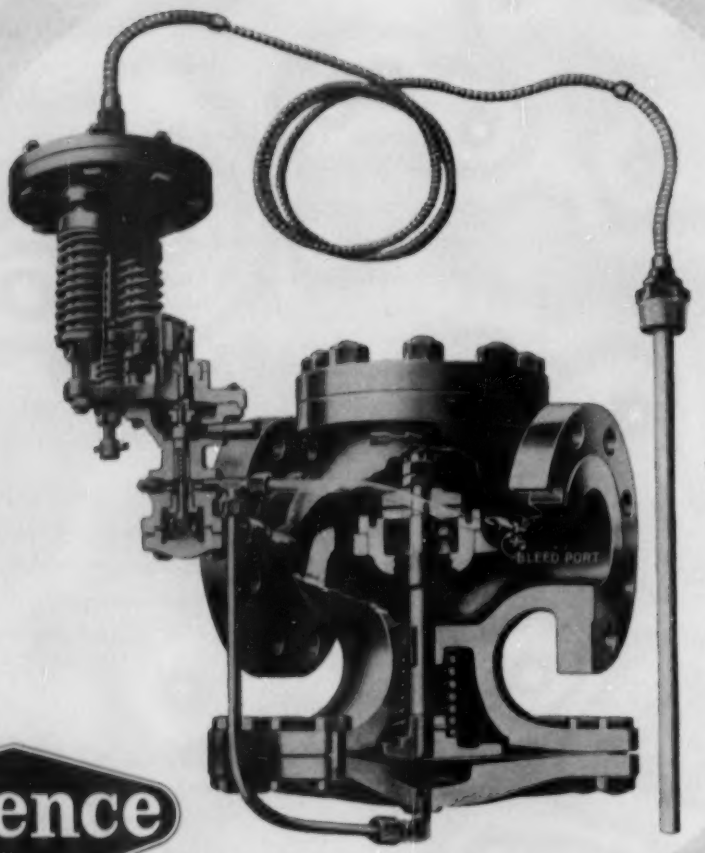
* When equipped with a SECO Metal Seat and Disc on steam service and protected by an approved Strainer, a Spence Regulator is guaranteed to shut tight when the demand for steam ceases.

Expensive steam leaks due to a lack of absolutely tight shutoff are eliminated in Spence Temperature Regulators. Here is why we can make such a guarantee:

First, our temperature regulators are of the single seat design. Seats and discs are made of durable SECO Metal. More than 20 years experience in thousands of installations has failed to produce a single case where SECO Metal has been cut by steam.

These plus other design features explain why Spence Temperature Regulators function dependably and accurately year after year without requiring expensive repairs or special attention.

Want more facts? Write for Bulletin T50 giving full details.



SPENCE
TYPE ET150
Temperature
Regulator

Spence

SPENCE ENGINEERING COMPANY, INC.
WALDEN, NEW YORK

Georgia Power Company looks ahead—

selects GULFCREST OIL for long range protection

Georgia Power Company's Yates Plant at Newnan, Georgia, has three 100,000 KW General Electric Turbines in operation and is adding a fourth, which will be a 125,000 KW unit. 3,450 gallons of Gulfcrest Oil in each of the lubrication systems provide safe, sure, long-lasting protection.

Gulfcrest Oil has been in service at the Yates Plant of Georgia Power since 1950. Turbine systems are clean, there is no rust, sludge, or foam. But this is only the beginning. Gulfcrest will provide safe, sure protection for many years to come. (Gulfcrest has been in continuous service in several large turbines for over 20 years.)

There are good reasons for Gulfcrest's recognition as the world's finest turbine oil. Carefully selected crude oils are thoroughly refined, then super-refined by Gulf's exclusive Alchlor Process. This removes the unstable hydrocarbons that accelerate oxidation, form sludge and harmful acids. Then the right additives are properly combined, and you have a turbine oil that delivers superior performance in every type of steam turbo-generator.

A trained, experienced lubrication expert—the Gulf Sales Engineer—is as near as your telephone. Have him recommend the right grade of Gulfcrest for your turbines. Consult the telephone directory for the number of your local Gulf office.

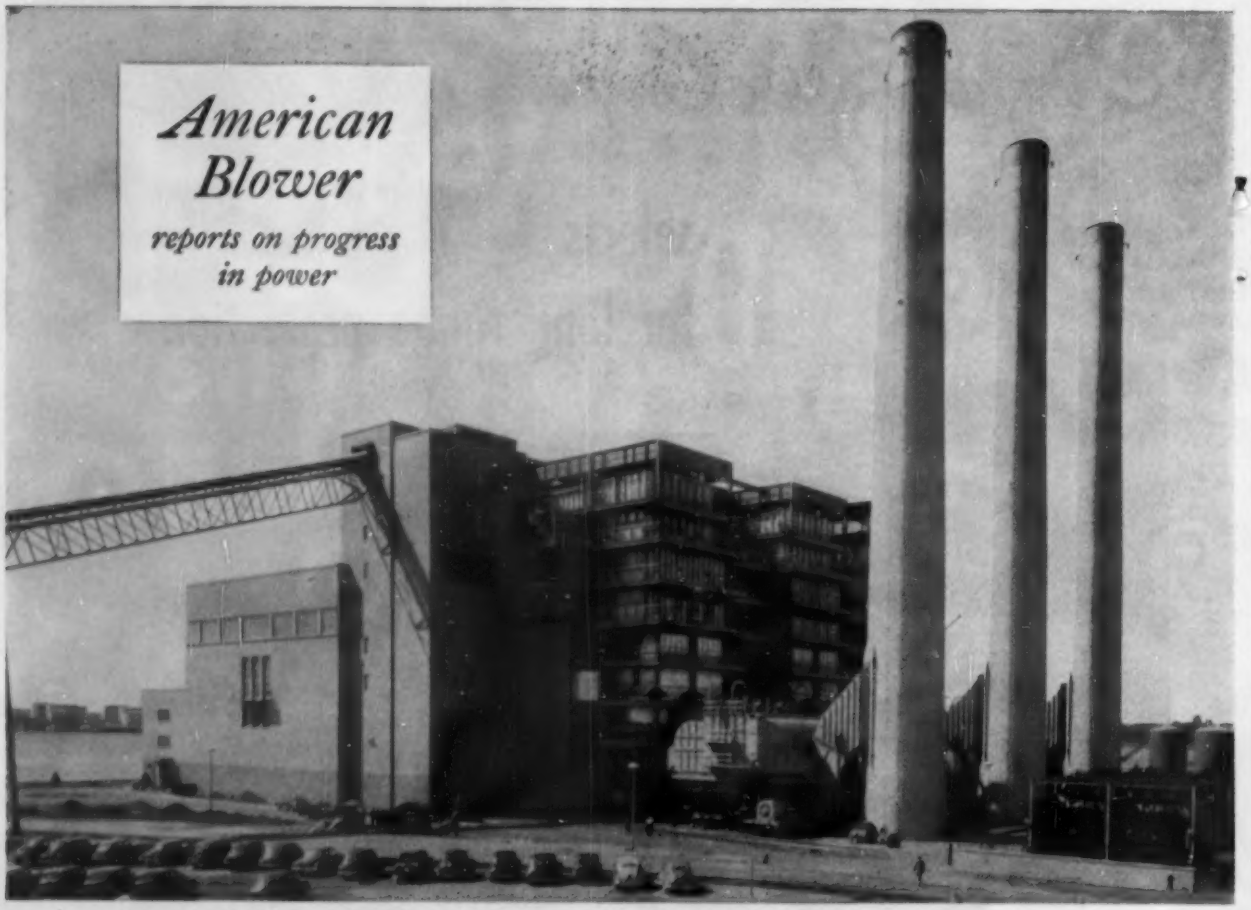
GULF

THE FINEST PETROLEUM PRODUCTS FOR ALL YOUR NEEDS

GULF OIL CORPORATION • GULF REFINING COMPANY
1822 GULF BUILDING, PITTSBURGH 30, PA.

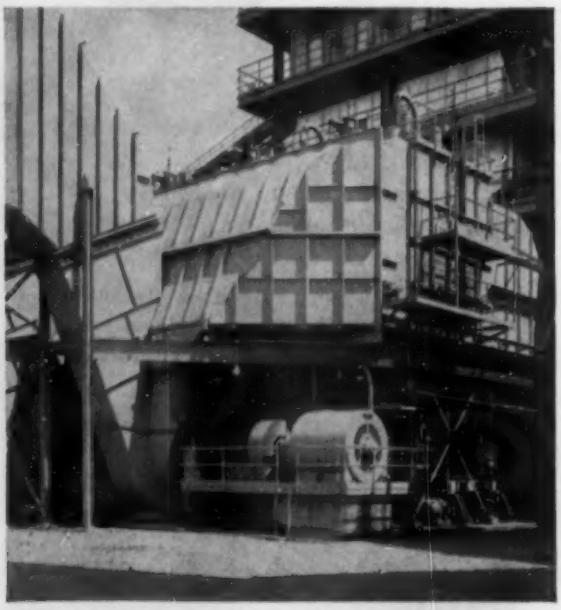
American Blower

reports on progress in power



Sewaren Generating Station, part of the Public Service Electric and Gas Company system, is the first station in operation to have used steam at 1050 degrees Fahrenheit. The semi-outdoor boilers, shown at right, were also an innovation in this latitude.

Sewaren coal tower has peak capacity of 700 tons per hour. American Blower Type L and Type T Gyrol Fluid Drives greatly simplify the coal-handling operation.



Close-up of one of Sewaren's eight American Blower Induced Draft Fans. Six are rated at 227,000 cfm of gas at 18.6" sp; two at 235,400 cfm of gas at 17.5" sp.

Sewaren...a milestone in power development

Long-range planning by the Public Service Electric and Gas Company gave New Jersey one of the nation's most advanced generating plants – the Sewaren Generating Station, at Sewaren. It houses facilities which, even today, are among the most modern known to man, for it was designed with the future in mind.

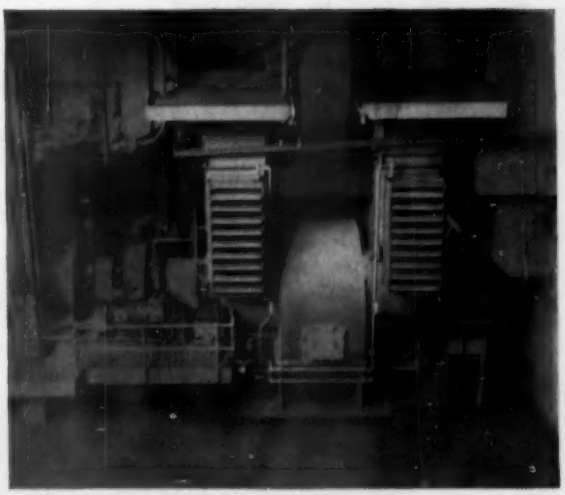
American Blower plays an important part in the operation of the Sewaren Generating Station. There are now *eight* Sirocco Induced Draft Fans, two equipped with Gyrol Fluid Drives, and *eight* American Blower HS Forced Draft Fans, each of which is also driven through Gyrol Fluid Drives. Rated at 2000 hp at 3465 rpm, twelve additional Gyrol Fluid Drives provide adjustable speed control of boiler-feed pumps.

What are your plans for the future? If they include expanding or modernizing your facilities, contact your American Blower or Canadian Sirocco Branch Office, now.

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American-Standard

AMERICAN BLOWER

Shown are six of the twelve boiler-feed pumps equipped with American Blower Type VS Class 6 Gyrol Fluid Drives, which are designed for high-speed applications.



This close-up shows one of eight American Blower Forced Draft Fans. Six have capacities of 123,000 cfm of air at 22" sp; two have capacities of 190,000 cfm of air at 15.0" sp.

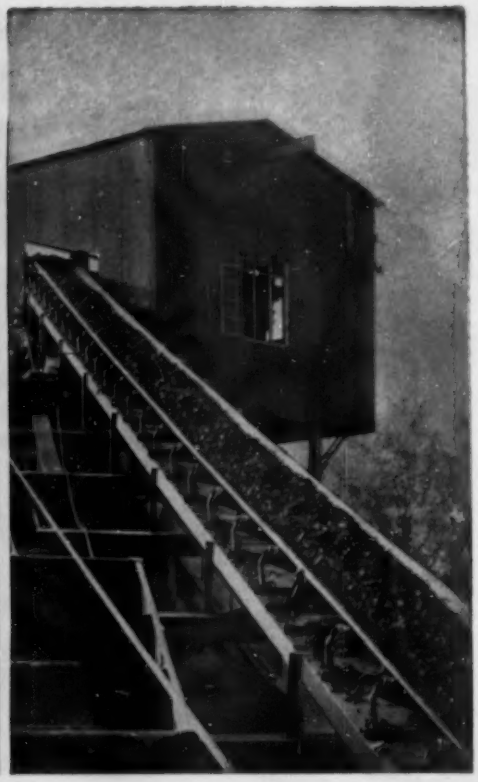
HOW TO BUY CONVEYOR BELTS

and get...
MORE USE PER DOLLAR
where
SPECIAL ENGINEERING
is needed

Look for a make of belt backed by experienced, specialized engineering service.

Selecting the right conveyor belt to solve a special problem begins with selecting the right representative . . . one who will take interest in your particular belt needs and refer your problems to his factory if engineering help is required. Where a company makes a wide selection of conveyor belts for many applications, the representative can often recommend a feature construction to meet your job requirements. Where your problem is unique, that company backs its field men with custom engineering and comes up with a recommendation to meet your specific operating conditions.

Choose the company that offers *complete* belt engineering service . . . the source of supply that maintains close contact between factory and field.



RAYBESTOS-MANHATTAN CONVEYOR BELT ENGINEERING

A leading steel mill, faced with handling hot sintered ore without an insulating layer of "fines", had numerous belt failures due to charring.

An R/M representative called in a factory engineer. A new custom-engineered R/M conveyor belt with special cover now saves hundreds of dollars a year at the mill.

and . . . where hot ash and clinker was wearing out a conveyor belt every month at a Michigan cement plant, an R/M field man was able to furnish a specially engineered Homocord Belt which has outlived the best previous belt four times over.

and . . . special, "chevron cleated" conveyor belt was developed by R/M, as a result of a field representative request, to replace a smooth surfaced belt unable to carry wet iron ore up a mine slope without costly spillage.

These are just a few of many instances where R/M engineering service has solved conveyor belt problems. In other cases, special job requirements have been met with R/M's exclusive constructions such as extra-flexible Ray-Man "F" . . . extra-cushioned Homocord for shock-loading . . . and Ray-Man Tension-Master for extra-high tensions and long lifts.

Let an R/M representative show you why R/M engineering makes R/M Conveyor Belts last much longer . . . give you "More Use per Dollar".

RM-502-A60

R/M

MANHATTAN RUBBER DIVISION—PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

Other R/M products include: Industrial Rubber • Fan Belts • Radiator Hose • Brake Linings • Brake Blocks • Clutch Facings
Asbestos Textiles • Packings • Engineered Plastic and Sintered Metal Products • Bowling Balls

here's how high temperature piping can flex its muscles

Each pipe hanger is scale tested to rigid tolerances by a skilled workman at the Navco plant. After final assembly and inspection, the hangers are carefully crated and readied for shipment.

NAVCO *Counterpoise* Pipe Hangers

Since high temperature piping has no respect for equipment connections, the entire piping system must flex its muscles to absorb the strain of expansion and contraction. This prevents serious stresses that could endanger the installation.

And how does high temperature piping flex its muscles? With Navco's precision engineered Counterpoise Pipe Hanger—the hanger with a load-supporting effort that is of constant value throughout the range of travel. This permits weightless movement of the entire piping system.

To learn how power plants, oil refineries and chemical plants can have piping systems that flex their muscles, write today for Navco's 12-page Counterpoise hanger bulletin #153.

NAVCO

NATIONAL VALVE & MANUFACTURING COMPANY

3105 LIBERTY AVENUE, PITTSBURGH 1, PENNSYLVANIA

New York • Chicago • Cleveland • Boston • Atlanta • Buffalo • Cincinnati

designed specifically for steam plant use . . .

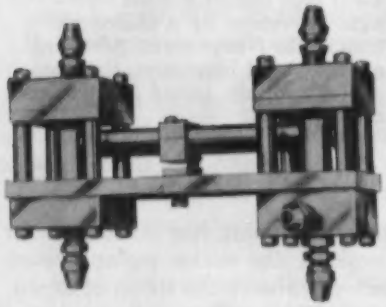
HAGAN AUTOMATIC COMBUSTION CONTROL SYSTEMS AND COMPONENTS

Hagan's long experience in the design of Automatic Combustion Control Systems has produced a line of instrument and control devices which are reliable, accurate and versatile. Each is available to the power plant engineer as a standard component. Used separately or in combination, they provide the engineer with a ready solution for any control or metering problem he may wish to engineer locally.

The components listed are just a few of the many Hagan units which have given such good service in complete Hagan systems that they have been adopted in many plants as standard for a variety of services. For details as to construction or applications, consult your local Hagan engineer, or write to the address below.

HAGAN

Adds, subtracts, multiplies, divides or proportions up to 3 separate signals



HAGAN RATIO TOTALIZER

The Hagan Ratio Totalizer is a compact, pneumatically-operated unit for combining accurately a maximum of three incoming signal pressures to produce an output signal pressure in the ranges of 3-15 psig, 0-30 psig or 0-60 psig.

Standard elements are available for input pressures up to 500 psig. An adjustable fulcrum provides means of changing the relation between incoming pressures and the output signal. This feature permits adjustment of proportional band.

Two input signals, representing separate measured quantities, may be added, subtracted or reversed. Reset or rate action characteristics are adjustable.

Multiple Ratio Totalizers may be connected to select the higher or lower of two input signals, for splitting an output signal in proportional parts, or for securing the combined characteristics of proportional band, reset and rate action.

HAGAN

For measurement of liquid level, specific gravity, etc.

TYPE FRB DIFFERENTIAL TRANSMITTER

The Hagan Type FRB Differential Transmitter uses the Ring Balance meter construction to produce a pneumatic signal linear with the pressure differential imposed on the measuring element. Standard output signal pressure ranges are 3-15 psig, 0-30 psig and 0-60 psig.

Ring assemblies are available for measuring full scale differentials over a continuous range of 0.5" WC at 10 psig to 420" WC at 3000 psig. The full scale pressure differential for any ring assembly is easily adjustable over a continuous range of seven to one.

For accurate measurement of flow or differential — the most versatile instrument is the

HAGAN RING BALANCE METER

The Hagan Ring Balance Meter is a flow recorder or indicator, simple in design and extremely accurate over a wide range of measurements.

Check these many distinctive features of the Hagan Ring Balance Meter

- There is a complete series of interchangeable sensing elements for full scale differentials from 0.5″ to 560″ WC. Static pressures up to 10,000 psig.
- Ring assemblies available with ample power at all flow rates.
- The differential measuring range of any ring is adjustable over seven to one range.
- Dead weight check of calibration takes only a few minutes. Meter need not be disconnected from the line.
- Automatic compensation for such factors as fluid density, pressure and temperature is a standard attachment.
- The Hagan Ring Balance Dual Meter has two separate rings mounted in a single case, making independent measurement of two differentials or rates of flow, recorded on a single chart.
- Pneumatic or electric transmission available for most models.

HAGAN

For measurement of differentials up to 300 psi at static pressures up to 3000 psig

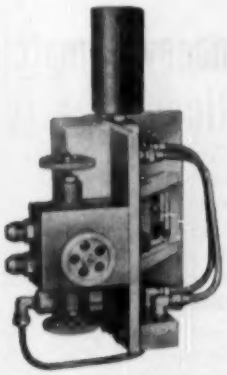
"DELTA P" PRESSURE DIFFERENCE TRANSMITTER

The Hagan "Delta P" Pressure Difference Transmitter is a compact instrument for measuring pressure differences at elevated static pressures and converting the measured value into a pneumatic signal pressure linear with pressure difference.

Full scale pressure difference measurement ranges from 0-50 psi to 0-3000 psi at static pressures up to 3000 psig. Signal pressure ranges are 0-30 psig and 0-60 psig.

The assembly employs directly opposed measuring bellows. No stuffing boxes or torque tubes are used. Seals are eliminated. Shutoff and bypass valves are integral and the assembly can withstand accidental application of full line pressure to either side of the measuring system.

The "Delta P" Transmitter is shock and vibration resistant.



HAGAN

Muscles for industry

HAGAN POWER POSITIONERS

Hagan Power Positioners provide plenty of power for accurate positioning of dampers, valves and other mechanisms in response to pneumatic signals received from automatic or manual transmitters.

Movement of the piston is normally linear with signal pressure, but this relation may be characterized by shaping the cam of the integral feedback mechanism.

Standard signal pressure ranges are 3-15, 0-30, and 0-60 psig. The usual power medium is compressed air between 40 and 100 psig.

Cylinder sizes range from 4″ to 12″ bore and from 5″ to 48″ stroke.

Accessories for most models include air failure locks, manual operators, limit switches, covers, etc.

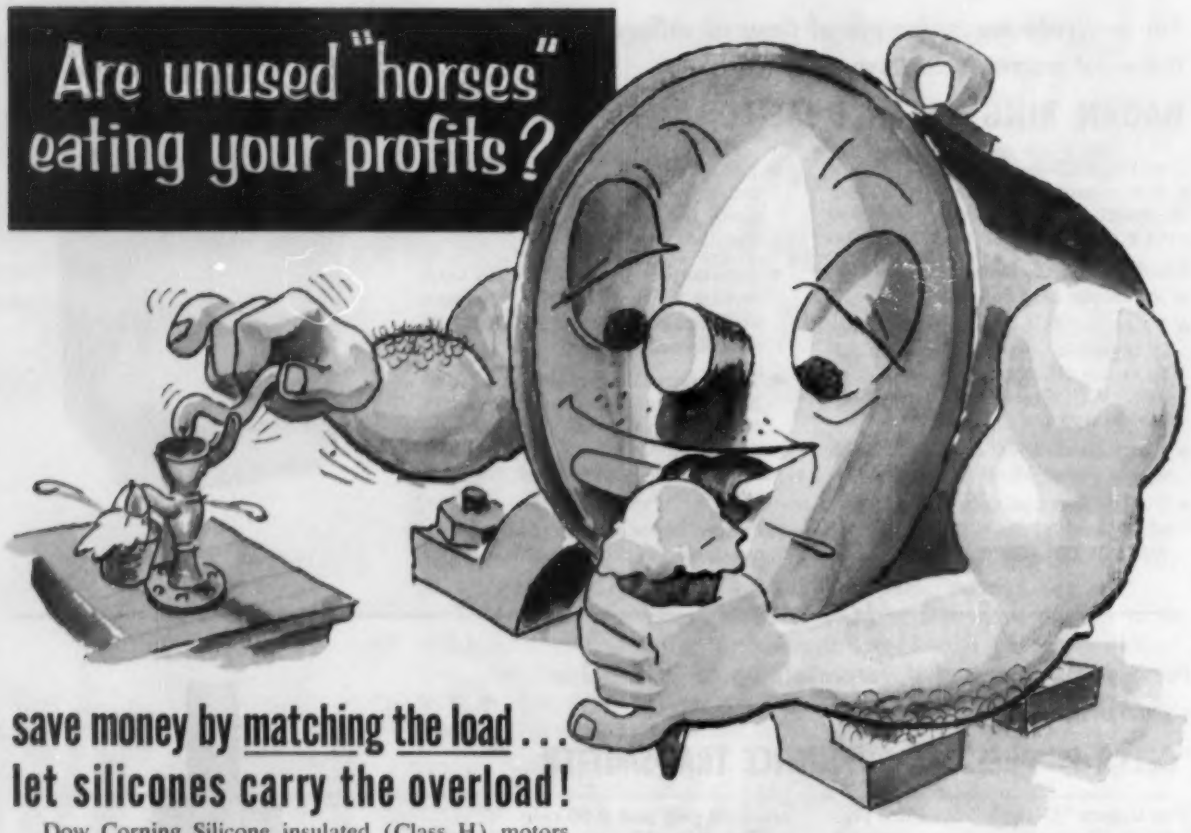
HAGAN HALL BUROMIN CALGON

HAGAN CORPORATION

Hagan Building • Pittsburgh 30, Pennsylvania

Boiler Combustion Control Systems • Ring Balance Flow and Pressure Instruments • Metallurgical Furnace Control Systems Control Systems for Aeronautical and Automotive Testing Facilities

Are unused "horses" eating your profits?



save money by matching the load . . . let silicones carry the overload!

Dow Corning Silicone insulated (Class H) motors give you a service factor ranging up to 50% compared with 15% for Class A.

This extra service factor enables you to install Class H motors rated at normal load requirements and yet meet initial or intermittent overloads, or loads that can't be matched in standard frame sizes.

In one of our fluid pumping applications, for example, normal load is 5 hp; intermittent loads range up to 9.2 hp. Instead of following the old fashioned practice of overmotoring with a 10 hp Class A motor, we use a 5 hp Class H motor and let silicones carry the overloads.

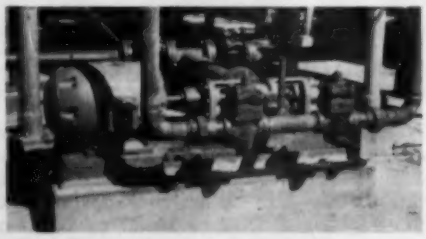
That means less capital investment in motors. It also means a better power factor and higher efficiency because smaller silicone insulated motors operate nearer full load more of the time than larger motors rated to meet maximum overloads.

And you get more reliable operation because motors insulated with Dow Corning Silicones have superior resistance to heat, and moisture and to corrosive atmospheres.

Remember, overmotoring is outmoded

to help you avoid overmotoring

Sier-Bath Gear and Pump Company, Inc. of North Bergen, N. J., now offers silicone insulated (Class H) motors as optional equipment on all of their positive displacement pumps. These Class H motors with their built-in service factor permit you to match the average load and safely carry initial or intermittent overload. You get all of the advantages of more compact equipment and more efficient operation.



Dow Corning Corporation, Dept. 6912, Midland, Mich.

Please send me sources of supply for new Silicone (Class H) ☐ Motors ☐ Transformers

☐ Information about Sier-Bath pumps with Class H motors

NAME _____ TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE ____ STATE _____

DOW CORNING SILICONES

DOW CORNING CORPORATION

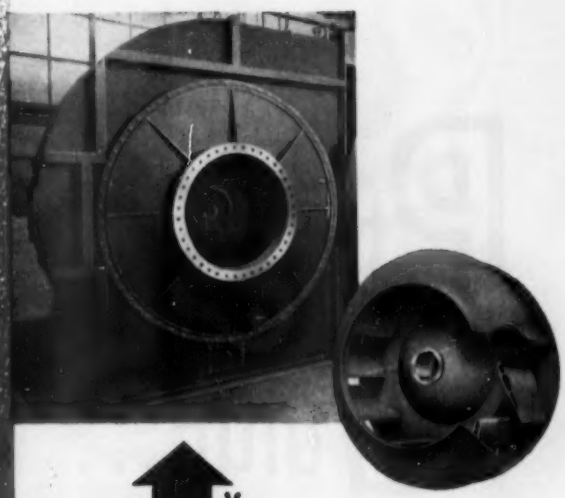
MIDLAND, MICHIGAN

ATLANTA • CHICAGO • CLEVELAND • DALLAS • DETROIT
LOS ANGELES • NEW YORK • WASHINGTON, D. C. (Silver Spring, Md.)

CANADA: Dow Corning Silicones Ltd., Toronto
GREAT BRITAIN: Midland Silicones Ltd., London
FRANCE: St. Gobain, Paris

GREEN

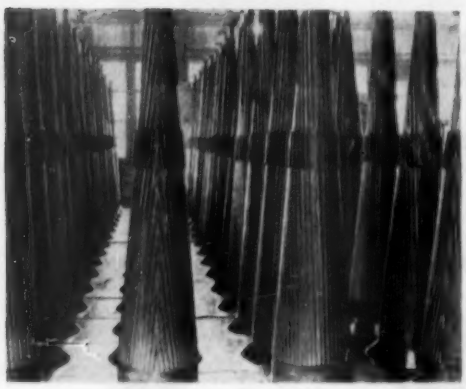
Specialists in Equipment That MOVES AIR STOPS FLY ASH



Two major items in the Green Line that have been enthusiastically accepted in the field are:

* **GALEX AIRFOIL TYPE DRAFT FAN**

AERODYNE FLY ASH COLLECTOR



The Galex Fan is available in 6 designs which provide highest static efficiency ratings over the widest range covered by any fan on the market. Let us send you a complete description of the fan, including performance data. Learn how the Galex offers surprising savings in annual operating costs of your installation.

The Aerodyne Collector recently solved another fly ash air pollution problem—for one of the largest utility plants in the country—at a minimum cost, in minimum time, with a minimum installation problem. If your installation involves flyash—or dust of any kind—it will pay you to investigate the simple, versatile, low cost Aerodyne system. Send us a brief outline of your operating conditions and our dust collection specialists will tell you precisely what the Aerodyne has to offer.

Green Power Plant Equipment has been serving industry in this country for more than fifty years. The Galex Fan and Aerodyne Collector are two more examples of progressive engineering which meets today's industrial and power plant requirements.

GREEN THE AIRFOIL TYPE FAN Galex FAN

THE GREEN FUEL ECONOMIZER COMPANY

POWER AND PROCESS PLANT EQUIPMENT

NEW YORK • CHICAGO • DETROIT

Representative in Principal Cities

BEACON 3, NEW YORK

Performance-- Value...

FIG. 16003—600-Pound Steel Pressure Seal Gate Valve.

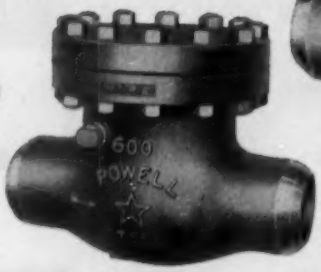


FIG. 6061 WE—600-Pound Stainless Steel Swing Check Valve.

...POWELL VALVES...THE COMPLETE QUALITY LINE...POWELL VALVES...

FIG. 3003 WE—Steel Gate Valve for 300 Pounds W.S.P.

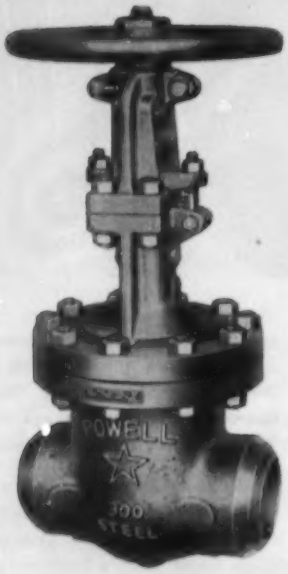


FIG. 1793—Iron Body, Bronze Mounted, Gate Valve For 125 Pounds W.P.

Powell Valves

You can depend on outstanding *performance* from every valve made by The Wm. Powell Company, for Powell Valves have a proven record of long life and dependable service.

And Powell Valves give you better *value!* They're precision made and incorporate many quality features—features that can save you money and give you lasting flow control.

Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our *COMPLETE quality line*, and help solve any flow control problem you may have.

The Wm. Powell Company, Cincinnati 22, Ohio ..... 109th year

5 OF A KIND...

The new A. E. C. project in Portsmouth, Ohio uses river borne coal to produce steam to generate electricity. Four identical Heyl & Patterson coal barge loaders . . . each with a capacity of 1200 TPH . . . take this coal from Ohio River barges. A fifth identical coal barge unloader has been placed in service at the Philip Sporn Plant, also located on the Ohio River.

These 5 Unloaders (2 were built for the Ohio Valley Electric Corp., 2 for the Indiana-Kentucky Electric Corp. and 1 for the Sporn Plant which is owned jointly by Ohio Power Co. and Appalachian Electric Power Co.) carry such standard H & P features as one man operation, automatic cable oilers, built-in service hoists and continuous reeving from large spools of cable.

Continuous reeving which saves many, many feet of valuable wire rope and precious man-hours, was an H & P "First."

Optional H & P features on these 5 Unloaders include an enclosed manlift, space for storage and repair of spare bucket and a motor generator set for adjustable voltage control of hoist and trolley motions.

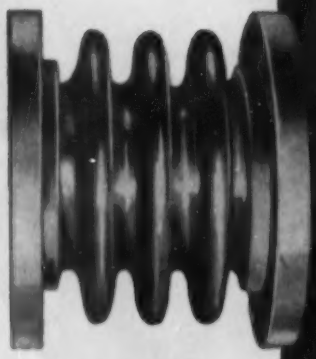
For more than fifty years Heyl & Patterson has been building Unloaders of various types and sizes for the handling of coal, ore, bauxite, sand, gravel, slag and other bulk materials from barges or ships. *When you have an unloading problem, phone or write for a Heyl & Patterson Engineer to consult with you.*

Heyl & Patterson
INC.

55 FORT PITT BLVD., PITTSBURGH 22, PA. • COurt 1-0750

- **Boat Loaders and Unloaders**
- **Cyclone Thickeners**
- **Coal Handling Equipment**
- **Thorsten Coal Samplers**
- **Coal Storage Bridges**
- **Rotary Car Dumpers**
- **Bradford Breakers**
- **Reineveld Centrifugal Dryers**

The Badger Non-Equalizing EXPANSION JOINT of Many Uses



Typifying Expansion Joint Engineering at its Best

- Absorbs Thermal Expansion
- Minimizes Vibration
- Compensates for Ground Settlement or Piping Misalignment
- Protects Costly Equipment Against Excessive Pipe Stresses
- Prevents Loss of Valuable Materials Flowing Through Pipe Lines
- Eliminates Maintenance Costs

The non-equalizing expansion joint is designed for use where pressures are low and thermal expansion is moderate. Available in copper and stainless steel in sizes up to and including 72" in diameter. Larger sizes and other materials can be furnished to meet special requirements. Also available in oval or rectangular shapes.

The Badger Non-Equalizing Expansion Joint can help you solve many of your piping problems. For full information, contact our nearest Sales Representative today.

BADGER MANUFACTURING COMPANY

Original and Sole Manufacturer of Badger Expansion Joints

230 BENT STREET, CAMBRIDGE 41, MASS. • 60 EAST 42nd STREET, NEW YORK 17, N.Y.

Representatives in Principal Cities

More efficient connections all three ways...

BRAZED

CLAMP TYPE

BOLTED

Because it's SQUARE!

CHASE® VENTILATED SQUARE
COPPER TUBE BUS CONDUCTOR!

Power gets a green light, even through the joints of Chase square copper tube bus! Those four flat sides have more than enough surface area for brazed, bolted or clamped connections to take a tight, highly conductive grip. Such firm and secure joints have high mechanical strength, too—withstand the distorting forces of heavy short-circuit current almost as well as beam-rigid Chase square tube bus itself! Add the increased current-carrying capacity of *cooler-performing*, ventilated Chase square tube conductor, and you have electrical main arteries second to none in performance!

Write for *free* Chase Bus Conductor Brochure *today!*

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The Nation's Headquarters for Brass & Copper

Atlanta	Chicago	Denver	Indianapolis	Minneapolis	Philadelphia
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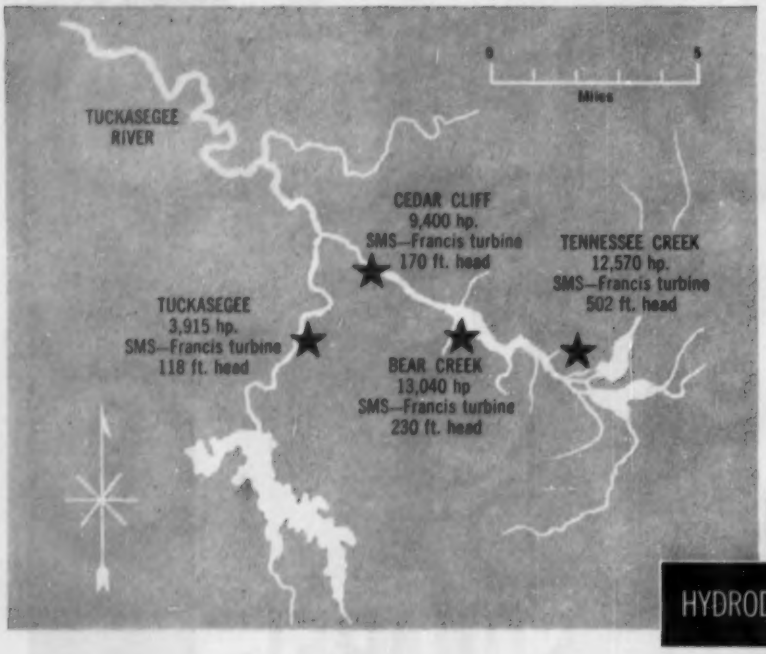
Boston	Cleveland	Grand Rapids	Los Angeles	New Orleans	Providence
Charlotte	Dallas	Houston	Milwaukee	New York	Rochester
St. Louis	San Francisco	Seattle	Waterbury		

HOW ALCOA GOT LOW-COST POWER
DEVELOPING MARGINAL SITES



Between 1949 and 1952, Alcoa developed extra hydropower at low cost from these small sites on the headwaters of the Little Tennessee River.

Cedar Cliff is typical of the small, unattended stations in this development.

HYDRODYNAMICS

To get additional hydropower at minimum costs, Alcoa and its subsidiary, Nantahala Power & Light Company, have reached into the headwaters of the Little Tennessee River. As shown on the sketch map, four small sites on the east and west forks of the Tuckasegee River and Tennessee Creek now permit far greater utilization of the available water. But to make such installations pay, construction, operating and maintenance expenses were carefully planned and closely controlled.

Each of the new facilities is remotely operated from an existing station. Rock fill dams and unlined tunnels helped keep costs down, while powerhouses were built just large enough for the unit. On the SMS turbines themselves, vulnerable parts were given protective coatings of stainless steel to reduce maintenance over the years.

SMS turbines at these four stations have a total rated output of approximately 39,000 hp. All four of these are SMS-Francis types, while at Queens Creek Station a 2,250 hp. SMS-Impulse turbine operates under a 999-foot maximum gross head. SMS butterfly and relief valves supplied with the Tennessee Creek installation.

Whatever your needs for hydraulic turbines and accessories, contact S. Morgan Smith Company at York, Pennsylvania.

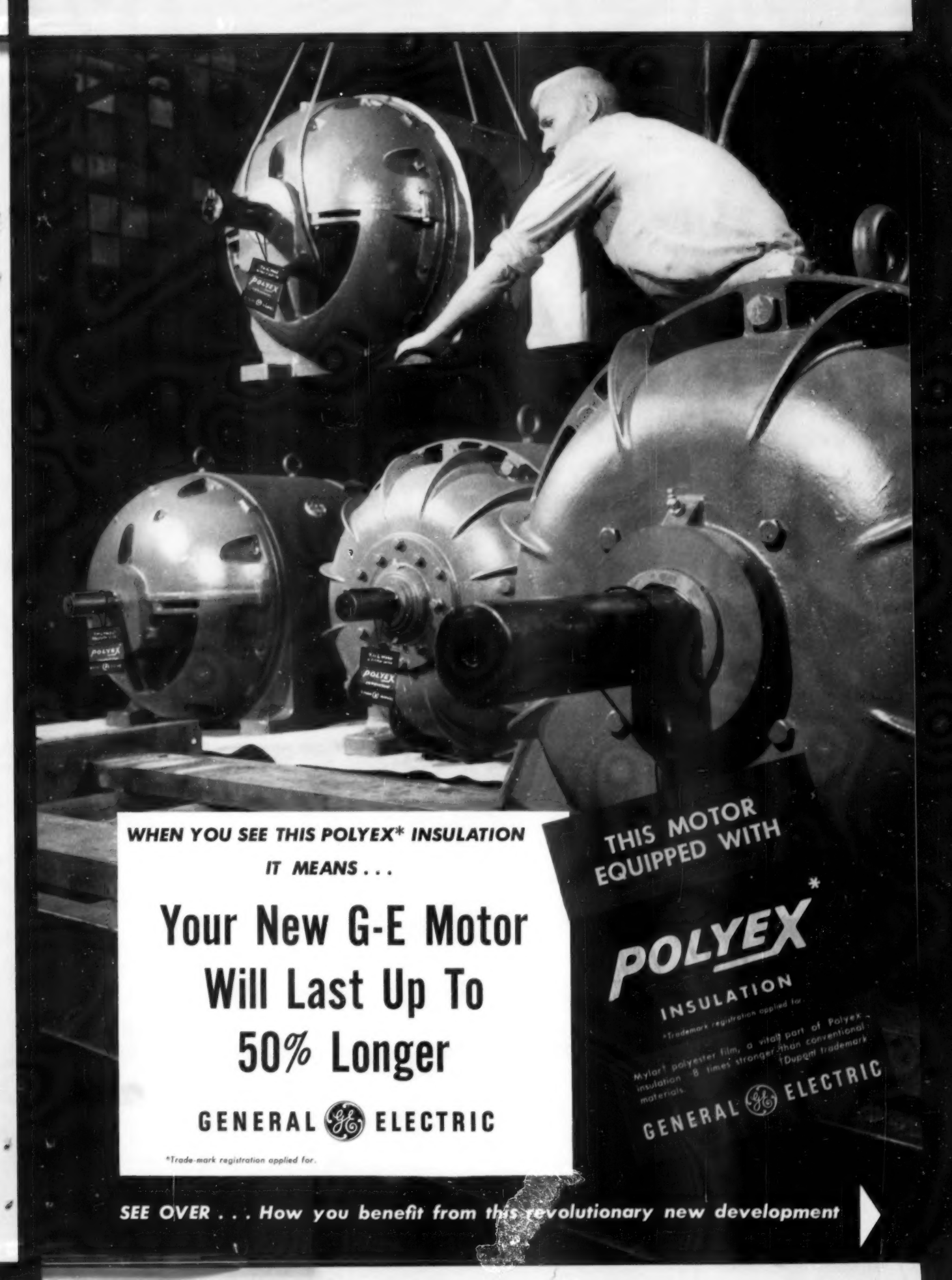
HYDRAULIC TURBINES
PUMPS
GATES & HOISTS
TRASH RAKES
ACCESSORIES

HYDRODYNAMICS

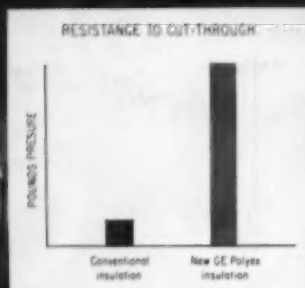
ROTOVALVES
BALL VALVES
BUTTERFLY VALVES
FREE-DISCHARGE VALVES
CONTROLLABLE-PITCH SHIP PROPELLERS

S. MORGAN SMITH

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

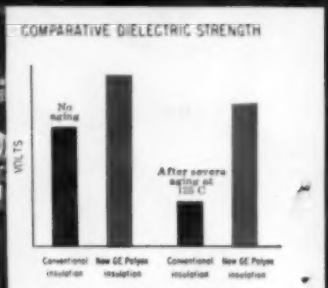

WHEN YOU SEE THIS POLYEX* INSULATION
IT MEANS . . .
Your New G-E Motor
Will Last Up To
50% Longer
GENERAL ELECTRIC
*Trade-mark registration applied for.
THIS MOTOR
EQUIPPED WITH
POLYEX*
INSULATION
*Trademark registration applied for.
Mylar† polyester film, a vital part of Polyex insulation 8 times stronger than conventional materials.
†Dupont trademark
GENERAL ELECTRIC
SEE OVER . . . How you benefit from this revolutionary new development

7 TIMES GREATER PHYSICAL STRENGTH



Cut-Through Test proves G.E.'s new insulation has extra protection against greater physical stress.

50% HIGHER DIELECTRIC STRENGTH

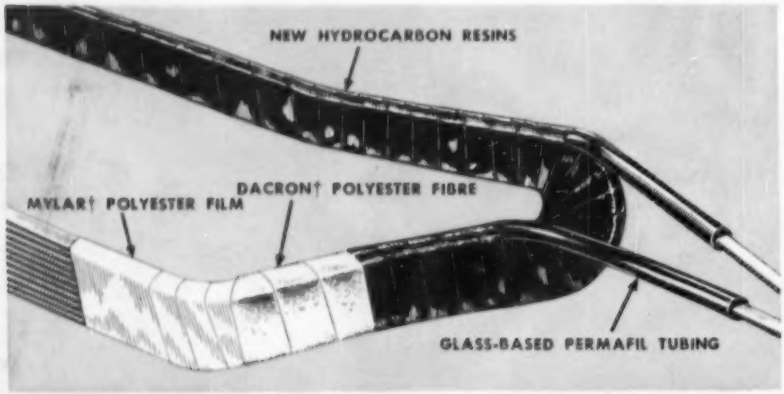


Tests prove new Polyex insulation can withstand much higher voltage stresses even after heat aging.

An important development for users of motors from 100 to 3000 HP. . . . . .

NEW *POLYEX* insulation developed by G.E. is 7 times tougher, adds years to motor life

Your new General Electric motors, in the 100 to 3000 HP range, will last 50% longer because of a revolutionary new insulation system called Polyex. A class A system, Polyex is composed of amazing new polyester films and fibres with a combination of toughness and high dielectric strength never before available in motor insulating materials. G.E. conducted hundreds of tests to find just the right balanced system of polyester films and fibres and hydrocarbon resins that would be able to stand increased physical and electrical stresses. The result is Polyex—the first major advance in motor insulation in 45 years.



G.E.'s NEW Polyex Insulation System for the first time takes advantage of new polyester film and fibres and hydrocarbon resins with natural insulating qualities of their own. Materials requiring impregnation for dielectric strength have been completely eliminated.

MANY BENEFITS

This new insulation system offers seven times greater cut-through strength, four times greater tensile strength, at least twice the contaminant resistance, 50% greater dielectric strength. This can add up to tremendous savings in reduced maintenance, reduced motor failures and longer trouble-free motor operation.

AVAILABLE IN COMPLETE LINE

The many advantages of Polyex insulation are now available to you *at no extra cost* in form wound General Electric induction motors from about 100 to 3000 HP. Your G-E Sales Representative has complete information. Contact him at the General Electric Apparatus Sales Office in your area. General Electric Company, Medium Induction Motor Dept., Schenectady 5, New York.

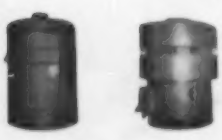
† DuPont trademark
* Trademark registration applied for.

836-3

Progress Is Our Most Important Product

GENERAL ELECTRIC

HERE ARE G-E LARGE MOTORS EQUIPPED WITH POLYEX INSULATION



Vertical TEFC and weather-protected

Totally-enclosed fan-cooled

Open drip-proof

Grade-mounted weather-protected

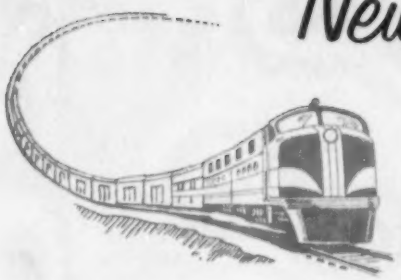
Base-ventilated weather-protected

Totally-enclosed air-water cooled

Boiler feed pump

Every minute handled 2,281,623 cu. ft. of air by CLARAGE in

New York's new Coliseum



...enough to fill a train of boxcars 5½ miles long

One of the biggest air handling assignments on record — and Clarage all the way!

For the Coliseum's colossal requirements, 75 Clarage Fans, 24 Unicoil Sprayed Coil Units, and 14 Multitherm Conditioning Units were selected. This choice, we feel, is an outstanding tribute to the worth of our equipment. Obviously, in a structure of this type, there could be no compromise with quality. Only the finest could qualify.

Make sure *your* investment in air handling and conditioning is a profitable one. Investigate the equipment we have perfected for every type of application.

CLARAGE FAN CO., Kalamazoo, Michigan

OWNER — Triborough Bridge & Tunnel Authority
ARCHITECT — Loon and Lionel Levy
MECHANICAL ENGINEER — Guy B. Panero
STRUCTURAL ENGINEER — Dr. Jacob Feld
GENERAL CONTRACTOR — Walsh-Fuller-Slattery
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CLARAGE ... *dependable equipment for making air your servant*

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal

O-B VALVES

BUILT FOR SEVERE SERVICE

O-B Globe Valves are designed for long life. For example, instead of making stem and disc holder in a single piece, Ohio Brass makes them separately. This permits "free swivel" action, with reduced wear on disc and seat. You can get O-B Globe Valves with long-life disc construction from your Ohio Brass distributor.

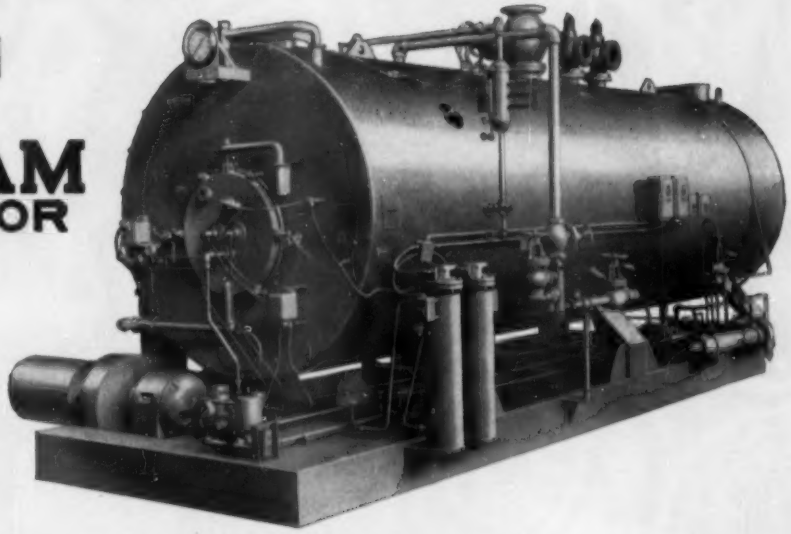
Ohio Brass

MANSFIELD OHIO, U.S.A.

4160-V

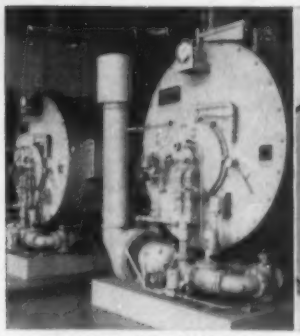
GET ALL THESE ADVANTAGES

WITH AN AMESTEAM GENERATOR



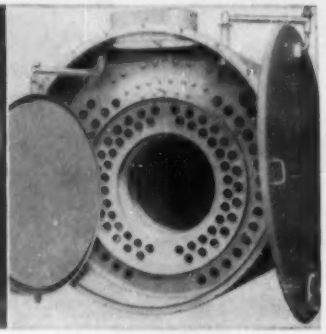
For:
PROCESSING
HEAT — POWER

20 sizes, 10 to 600 H.P., 15 to 200# W.P., oil, gas or oil-gas combinations with quick fuel switchover feature.



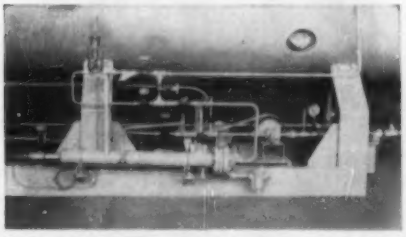
FULLY ASSEMBLED

All piping, wiring and operating parts completely assembled and tested at factory — units shipped in ready-to-fire condition!



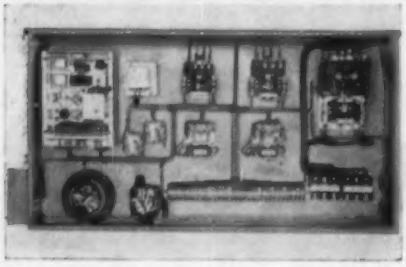
EASY TO CLEAN

Ames-designed davit hinged flue covers and baffle provide quick and complete access to the furnace and all tubes.



AMPLE ROOM

underneath for servicing auxiliary equipment. Control panel at eye level.



AUTOMATIC

operation, fully safeguarded, is provided by factory installed and tested control system.

SAVINGS IN FIRST COST!

Your purchase price includes complete unit — no hidden "extras" to buy later on!

SAVINGS AT INSTALLATIONS

Just set on level concrete floor, connect to service lines and breeching. Nothing to assemble. No brick work required.

SAVINGS IN OPERATION

A minimum of supervision — lower manhour requirements for maintenance — easily replaced inexpensive plastic refractories — 80% thermal efficiency.

Write for bulletin today!

AMES IRON WORKS, INC.
Oswego, N. Y., Box H-125

Gentlemen:

Please send me further information on AMESTEAM GENERATORS and name of nearest representative.

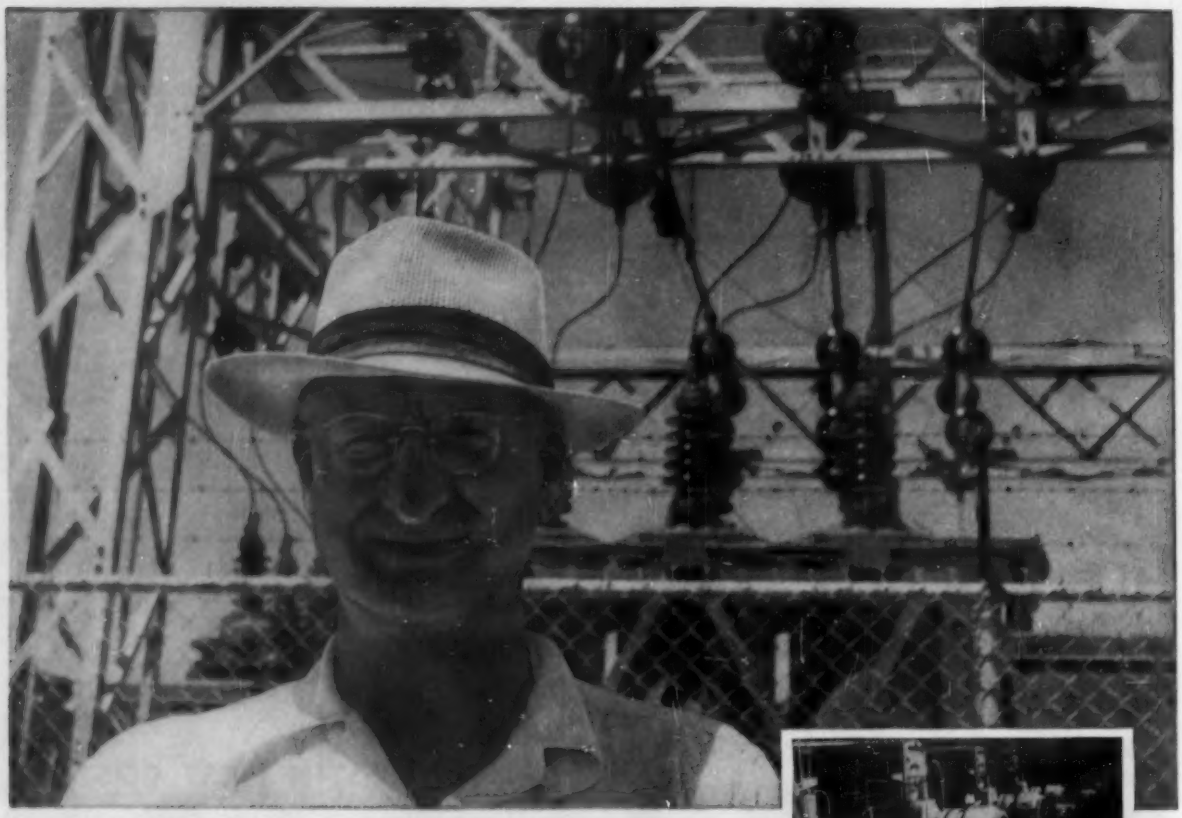
NAME.....

COMPANY.....

ADDRESS.....

AMES IRON WORKS INC.

BOX H-125 OSWEGO, N. Y.



POWERFUL GUY!

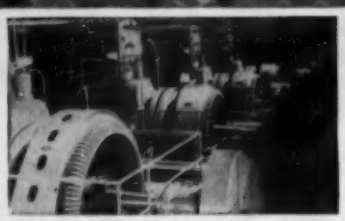
His four Nordberg Diesels, lubricated by Cities Service DC-940 Oil, supply six Oklahoma Counties with REA power. Have one of lowest cost-per-KWH records of entire REA.

His name's H. P. Wingo, and he's Chief Engineer of the REA plant operated by Western Farmers Electric Cooperative.

For the past four years, since his plant began operation in Woodward, Oklahoma, he's been responsible for a consistently high power efficiency rating, measured in cost per kilowatt hour...as high as fifth among all 42 REA plants! To maintain this record, he's had important help... help from four 1100 KW Nordberg dual-fuel engines...and help from Cities Service DC-940 Oil.

"Our engine compressions are the same today as they were after the first three months' operation," says Wingo. "In addition, using Cities Service DC-940, rings have remained absolutely free, liners have worn less than .0015, and we average 14,000 horsepower hours per gallon of oil. Filter elements last up to 1,500 hours."

Wingo has added his words of praise to those of scores of other users of Cities Service Lubricants. Summed up, these reports clearly demonstrate that superior performance is not the exception, but the rule, with Cities Service products. Your Cities Service Lubrication Engineer can readily explain why. Talk it over with him. Or write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.



4 NORDBERGS, 4 YEARS OLD ... yet engine compression remains the same as after first three months of operation at Western Electric REA Plant, Woodward, Okla. Rings "absolutely free," liners worn less than .0015, oil consumption at 14,000 H.P. hrs. per gallon using Cities Service DC-940 Oil.

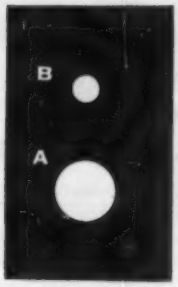
CLOSE CHECK is kept on entire operation. Meanwhile, Cities Service Lubrication checks wear in Nordberg engines, helps engineer Wingo maintain record of low cost electricity. Supplying economical power to six Oklahoma Counties, plant's power efficiency rating has been as high as 5th in entire REA.

CITIES SERVICE

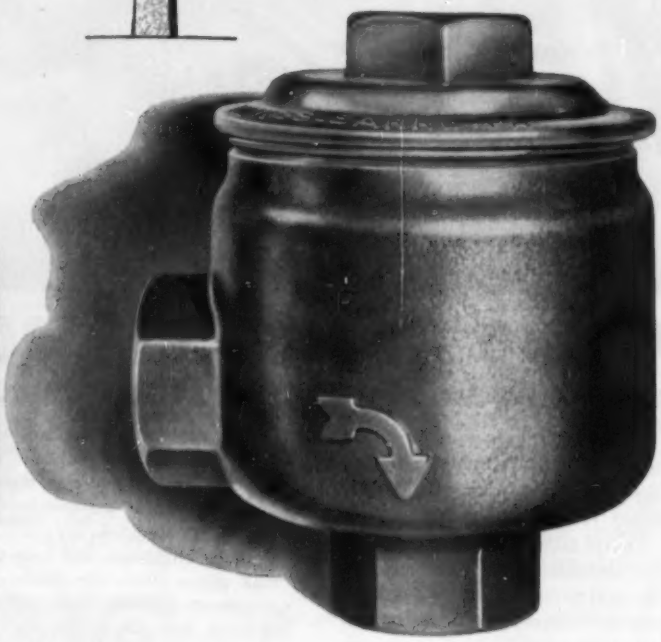
QUALITY PETROLEUM PRODUCTS

TALK ABOUT

Capacity



Discharge orifice of 1" NICHOLSON trap (A) compared with other types of same size (B). Nicholson's greater—in every size!



Compare capacity of a Nicholson Steam Trap with any other trap of same size. Greater capacity—right across the board—means Nicholson Industrial Traps discharge condensate and air from steam lines and process equipment *faster*, more *effectively*. In toughest steam distribution service, Nicholson's pay off 4 ways:

- **lower initial cost—more for the money**
- **less upkeep expense—minor maintenance**
- **faster warmup—high, even temperatures**
- **faster production—increased 20% to 30%**

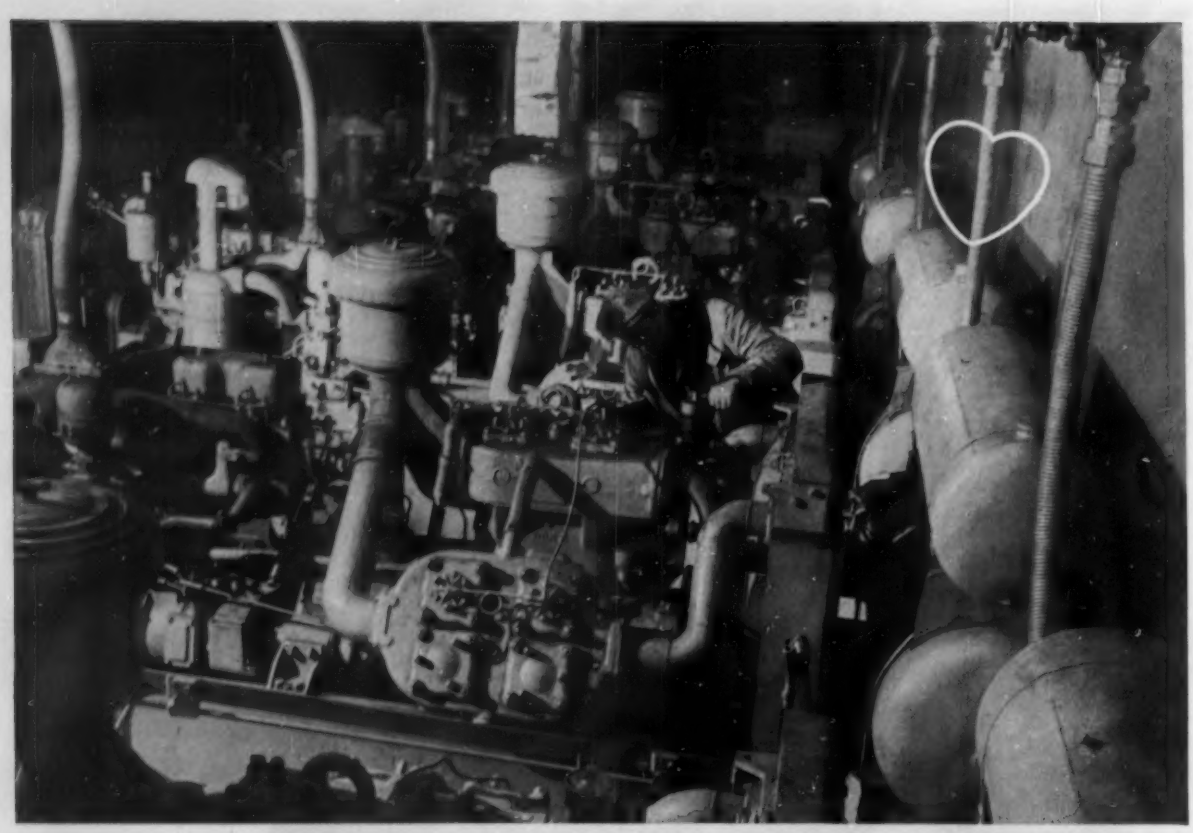
Where performance counts, specify Nicholson. Write for *Catalog 953*.

NICHOLSON

W. H. NICHOLSON and Company

TRAPS • VALVES • FLOATS • METAL PARTITIONS

14 OREGON STREET, WILKES-BARRE, PA. • SALES AND ENGINEERING OFFICES IN 58 PRINCIPAL CITIES



TAKES POUND OUT OF AIR POUNDING

DURABLE Penflex TUBING ABSORBS NOISE . . . VIBRATION . . . PUNISHMENT

"Transports air, but not the vibration" is remark often heard about Penflex tubing installed on air intake and exhaust lines. And for this room where a battery of eleven air compressors are operating, that can mean a lot of air in motion . . . and plenty of noise eliminated.

There's no question of air leakage, either. Penflex four-wall interlocked flexible tubing is as tight as the proverbial drum. In durability it has the edge over rigid pipe, for the many interlocked sections have a "give" which soaks up the minute but ceaseless vibration which causes ordinary pipe to fracture . . . in addition to absorbing an ear-splitting din.

Penflex tubing can be built up to pressures . . . or down to size—as small as ⅛" I. D., or as large as 24" I. D. Different types, weights and materials are available. Selection of the tubing best suited for the job is a specialized segment of engineering . . . "Flexineering," we call it.

Penflex engineers will help you to "Flexineer"—one job or an entire plant—for steam or Diesel power generators, compressor stations, various oil, water and steam circulating lines, bulk unloading, or a host of other jobs.

You'll find our booklet "Flexineering" helpful, too. Write for a copy today.

Pennsylvania Flexible Metallic Tubing Company, Inc., 7237 Powers Lane, Philadelphia 42, Penna. • *Branch Sales Offices:* Boston New York • Chicago • Houston • Cleveland and Distributors in Principal Cities

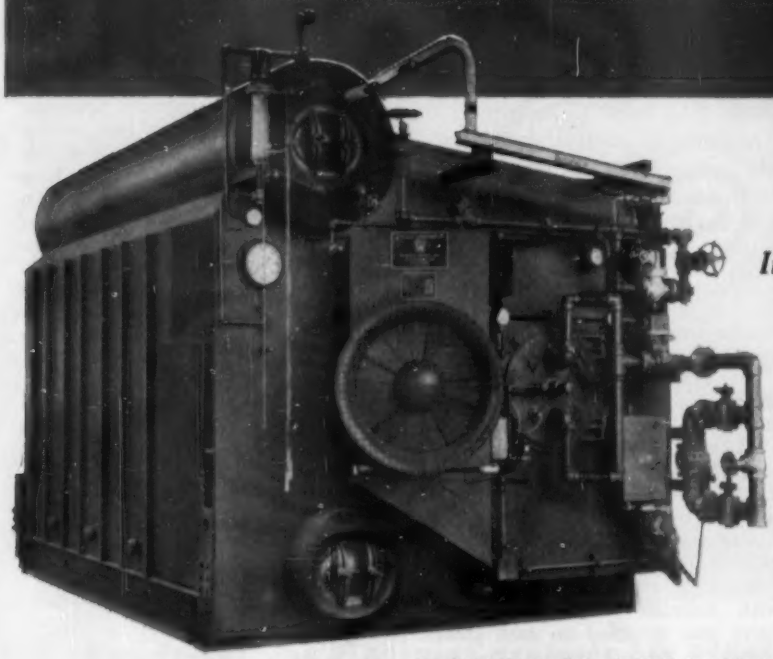
flexineering by

PENFLEX

HEART OF INDUSTRY'S LIFELINES

FLEXIBLE TUBING, AUTOMATIC BARREL FILLERS, PNEUMATIC RIVET PASSERS, ACCESSORIES AND FITTINGS

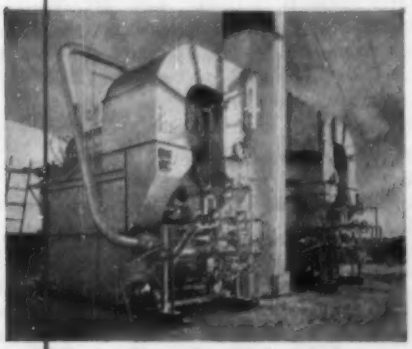
15 YEARS EXPERIENCE
in packaged steam generators



New Foster Wheeler Series AG-100 Packaged Steam Generator.

In 1940 the original water-tube packaged steam generators —two Foster Wheeler units— were installed for oil field drilling operations.

Two FW packaged boilers—the first ever offered to industry—were installed in 1940 and are still in service delivering low-cost steam.



Now, with many successfully operating packaged units in service for processing, heating and generating, backed by 60 years experience in the power industry, Foster Wheeler offers the new "Series AG-100".

The new Series AG-100 shop-assembled water-tube steam generator is supplied for capacities from 10,000 to 46,000 lb steam per hour for oil or gas firing. It provides such significant advantages as baffled steam-collecting internals, the most efficient boiler surface arrangement, tangent furnace side wall and roof tubes which minimize refractory maintenance and provide cool operation, greater adaptability and accessability.

For more detailed information, write for new catalog PG-55-3, *Foster Wheeler Corporation, 165 Broadway, New York 6, New York.*

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

(Advertisement)

Hall Industrial Water Report

VOLUME 3 DECEMBER 1955 NUMBER 6

It Takes a Lot of Water to Process Food

In this 60-billion-dollar-a-year business, Hall helps to keep production up by keeping troubles with water down in plants from Massachusetts to California and from Florida to Washington. Not only the conditioning of water for steam power and steam heating, for cooling and for cleaning and processing, but also the processing of waste water for re-use, requires expert consultation and continuing service.

Maintenance Reduced in Plant Condensate System

Severe corrosion was being experienced throughout the condensate system of an Eastern chocolate manufacturing plant, with periodic replacement of sections of return line. Robert Dow, service engineer in the Boston office of Hall Laboratories, suggested a survey with corrosion test specimens to determine how much the use of Hagafilm® might improve conditions.

Weight losses on the test specimens before treatment revealed corrosion rates in most of the return lines sufficiently high to justify treatment. Simple gravity feed of Hagafilm to the boiler feedwater at the suction side of the boiler feed pump was accordingly started.

During the first three months, old corrosion products loosened by the action of the filming amine occasionally plugged traps and strainers. Then the intervals between maintenance calls lengthened until six months would elapse without a single call for a trap to be cleaned or a corroded pipe fitting to be replaced.

When Bob Dow suggested further tests with specimens to measure the effectiveness of the Hagafilm, plant personnel said they already had all the evidence they needed.

Sweetened Boiler Water Not to Plant's Taste

A call for help reached Hall engineer Robert Hobek from a fruit processing plant in Kentucky. Carryover from a boiler suggested that a slug of sugar syrup had somehow leaked into the condensate return system.

Steam coils used to heat some of the processing vats were immediately suspected, since the vacuum created when the steam was shut off could suck the liquid from a vat through any leak in the coil. A careful check revealed the expected perforation in one of the coils. This was repaired and all other coils were checked.

Most of the cooking was done with jacketed kettles so a drain valve was installed on each steam jacket, to be left open at the end of each day. In the morning the steam inlet valve to each jacket was partially opened and the first condensate running out of the drain valve was checked visually for any color indicating contamination.

Jacketed equipment is now used exclusively in the plant. No further difficulty with the sweetened boiler water has been experienced.

Fungus Attack on Cooling Tower Stopped

A mossy organic growth found in patches above the spray line in the top of their cooling tower was cause for concern to an Eastern food processing plant. Hall Laboratories' representative Jack White hurried samples to Hall headquarters in Pittsburgh for examination.

Out of the laboratory came the report that the damaged wood was infected with the same destructive fungus which had played havoc with a number of cooling towers in the Gulf Coast area, in one instance to the extent of $100,000 a year for replacement of wood.

Quick direct treatment of the wood was necessary. Hall engineer Ed Stewart arranged to have the plant personnel spray the cooling tower three times in a month with a trichlorphenate compound, soaking the wood thoroughly each time. An inspection then showed no signs of fungus attack in the zone where previously it had been severe. The plant has continued to spray the tower periodically with excellent results. No sign of fungus attack has yet appeared on a test board installed in 1953.

Plants which are not able to shut down periodically for spraying can protect the wood for prolonged periods by treating it successively with two water-soluble chemicals which interact to form a precipitate with fungicidal properties deep within the wood.

Hall Helps Hams

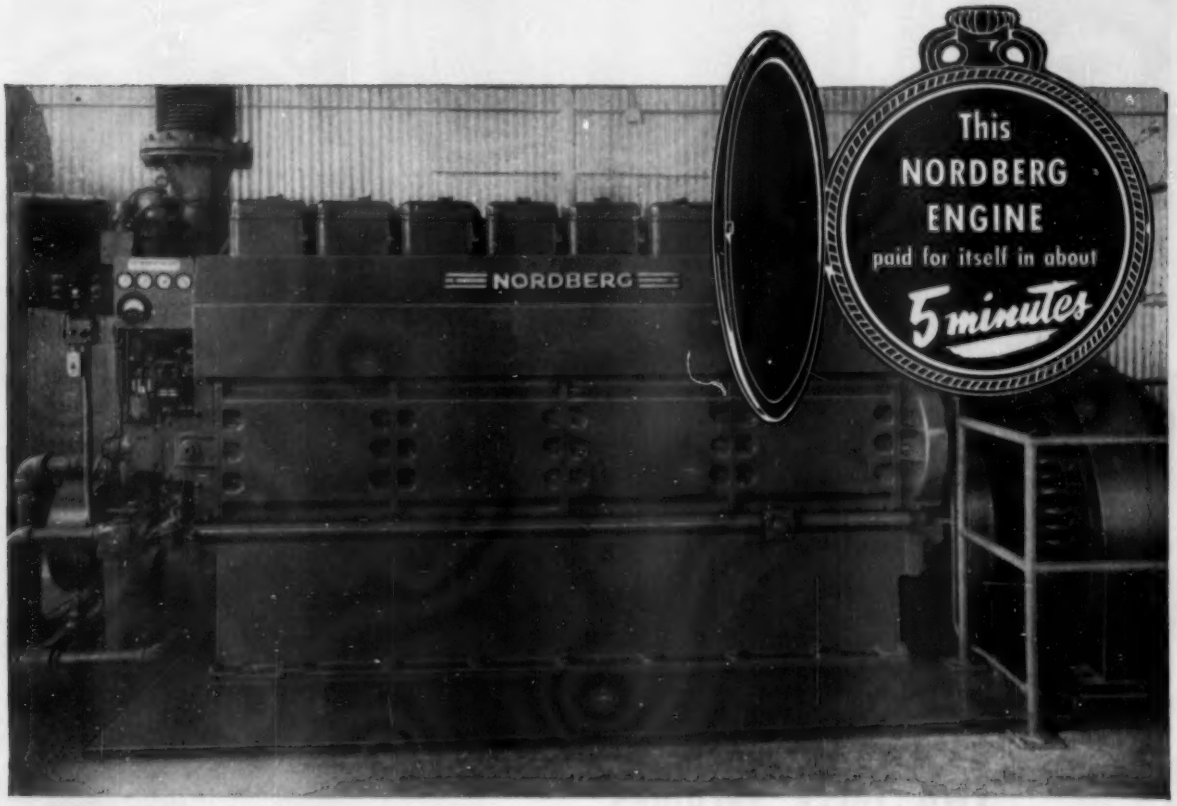
Hottest development in the curing of hams is an invention by G. O. Hall of Hall Laboratories described in U. S. Patent 2,513,094, now being developed commercially by Calgon, Inc., under the trade-mark Curafos.® By the properly controlled use of complex phosphates in the pumping pickle injected into the ham to produce the cure, the meat will retain its attractive color even when sliced and exposed to fluorescent lights at retail meat counters.

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information, write, wire or call Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

Water is your industry's most important raw material. Use it wisely.

Hall Laboratories, Inc.—Consultants on Procurement, Treatment, Use and Disposal of Industrial Water



Owens-Corning Fiberglas protects big plant investment with dependable Diesel stand-by power . . .

This Nordberg 720 hp, 500 kw Diesel generating unit supplies emergency power for the big Owens-Corning Fiberglas plant at Santa Clara, California.

To guard against shutdown caused by a failure of purchased power, the Nordberg Diesel is ready to take over the plant load at once, thereby protecting a huge plant investment in costly processing machinery. To make sure full power is instantly available, the engine is constantly maintained at operating temperature. Once each day the engine is started, paralleled with purchased power, and the plant load taken over for a short period . . . assuring its readiness, and training personnel for emergency operation.

Since this installation was made, several main power failures have occurred without warning. *In each case, the Nordberg stand-by unit was on the line and supplying emergency power within three minutes.* This service has more than saved the Diesel's original cost.

Here, then, is another outstanding example of the way Nordberg engines are serving industry.

NORDBERG ENGINES FOR EVERY POWER NEED

For regular or emergency service, you can't beat the advantages of Nordberg Diesels. They can be added to the line quickly, can be held ready for instant service without exorbitant standby expense, and are available for fully automatic operation. In the complete line of Nordberg two and four-cycle Diesel engines, including both oil and gas burning types, you will find exactly the right unit to meet your present and future power requirements . . . from 10 to over 12,000 horsepower.

NORDBERG

DIESEL • DUAFUEL® AND SPARK-FIRED GAS ENGINES

NORDBERG MFG. CO.
Milwaukee, Wisconsin
Builder of America's Largest Line of Heavy Duty Engines

MAIL THIS COUPON TODAY

Nordberg Mfg. Co., Milwaukee, Wisconsin

Send information on Nordberg engines in the _____hp range for_____service.

Name_____

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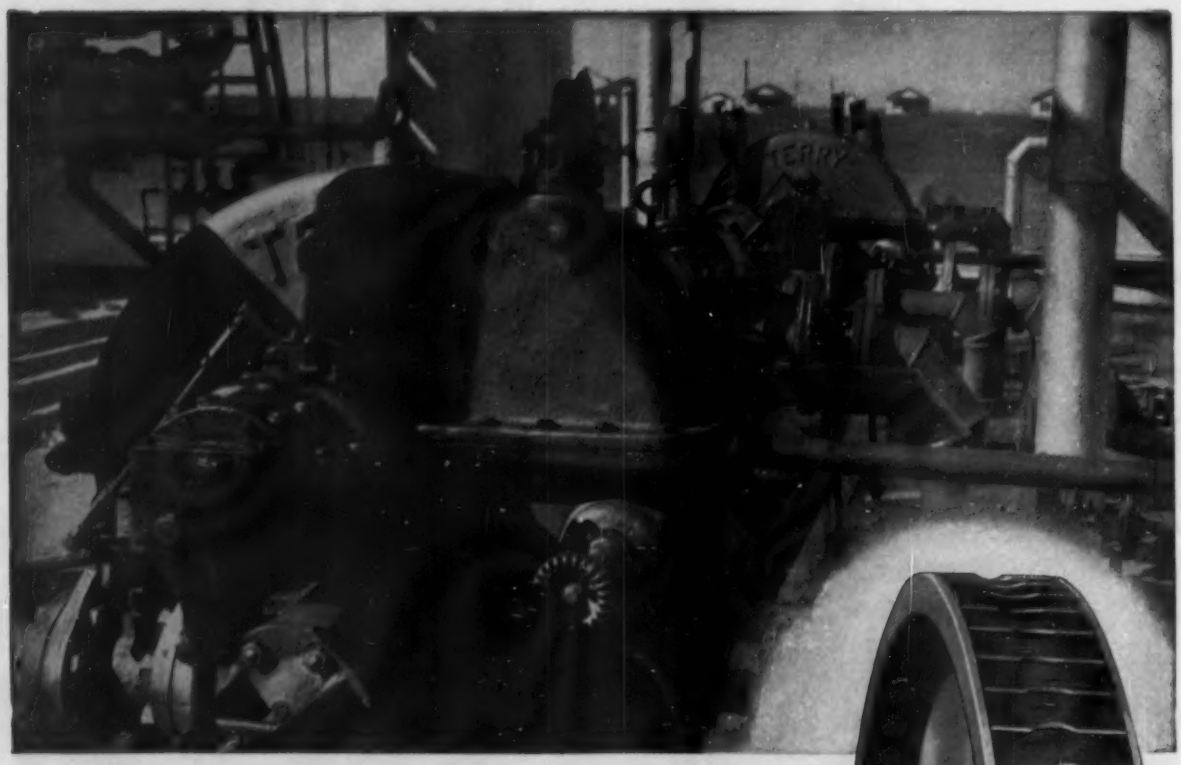
P655-R



Two Terry Turbines equipped with "trouble eliminators"

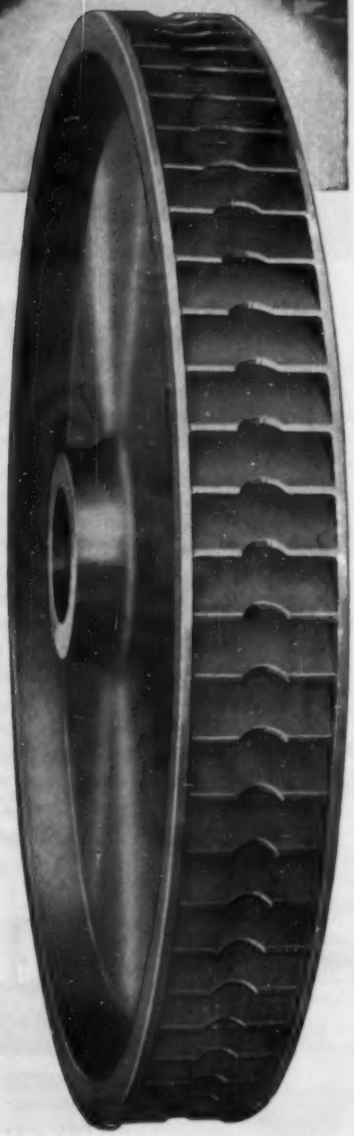
Because these turbines have solid wheels, they can take a lot of abuse, without complaint. Here's why:

1. The wheel has no separate parts to become loose or work out. It is a single forging, in which a series of semi-circular buckets is milled.

2. Blade wear is of little consequence because the power-producing action of the steam takes place on the curved surfaces at the back of the buckets. Wear does not materially affect horsepower or efficiency.

3. The blades cannot foul. There is a one inch clearance on either side of the wheel and, in addition, the blades are double rim protected. There is no need for close axial blade clearance, because the steam enters the buckets in a direction at right angles to the shaft.

For complete details of these *work horses of industry*, send for a copy of bulletin S-116. No cost or obligation.



THE TERRY STEAM TURBINE CO.

TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TS-1199

higher loads...
economy fuels...
new
engine designs...

there's one answer for all three of these lubrication problems—

Demands upon the lubricant in stationary industrial engines are increasing. More severe operating conditions caused by heavier loads, new engine designs and the use of economy fuels pose difficult lubrication problems not met by conventional oils. Standard Oil Company introduces a lubricant specifically designed to meet these problems—STANODIESEL Oil M.

STANODIESEL OIL M

STANODIESEL Oil M meets or exceeds the requirements of a lubricant for stationary industrial engines. Here's why:

STANODIESEL Oil M is refined from the highest quality base stock. It has superior stability.

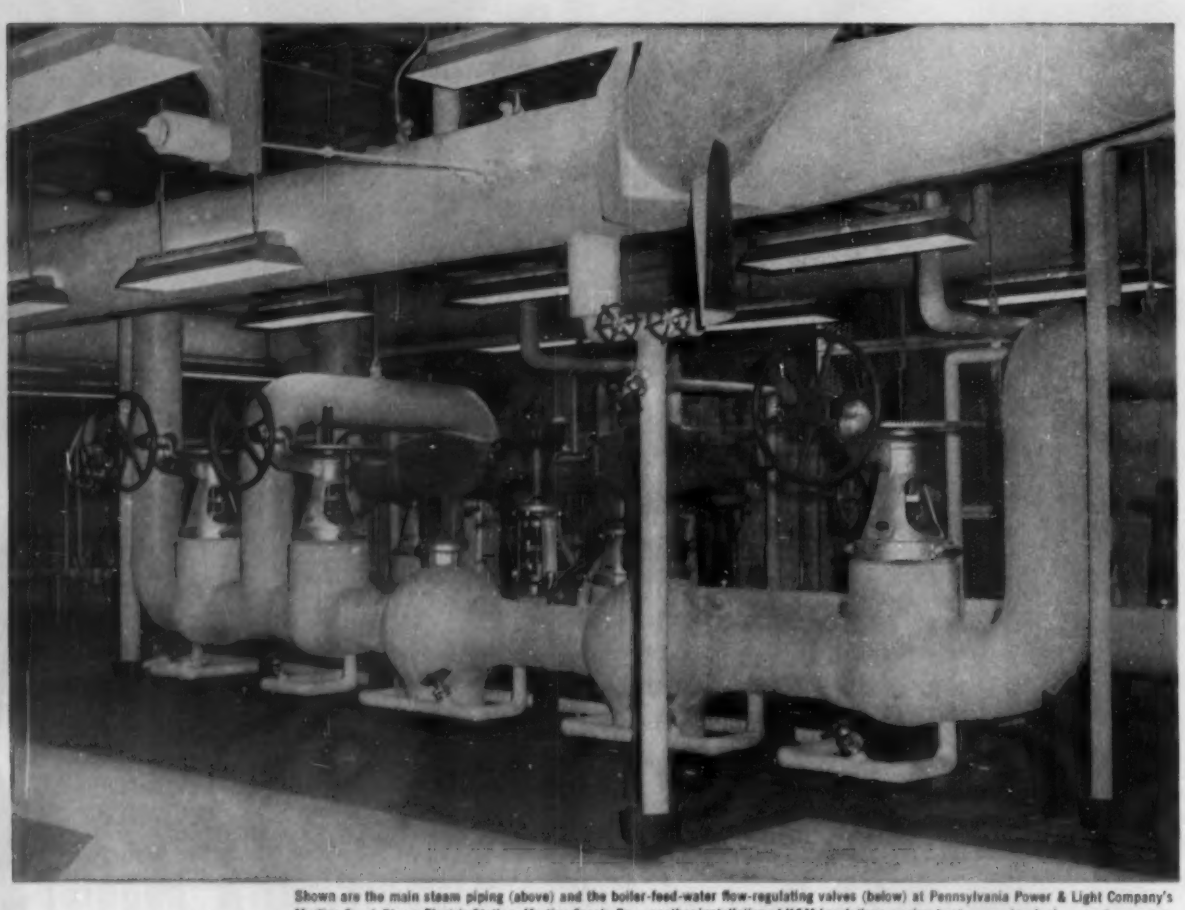
Special additives are blended with this STANODIESEL Oil M base stock. An oxidation inhibitor prevents unwanted increases in oil viscosity and prevents corrosion of bearings. The action of detergent-dispersant additives keeps crankcase, pistons, cylinder walls and other parts clean. Contaminants are kept in suspension and are prevented from depositing. An anti-foam agent makes this oil suitable for use in hydraulic governors. A wetting agent increases the oil's ability to reach and maintain a film on such highly stressed parts as cams and cam followers.

Use of STANODIESEL Oil M means this: less engine deposits, less ring and cylinder wear. Less spark plug fouling when used in gas engines. Eliminates fuel injector and pump sticking caused by deposits on the injector barrel and plunger when fuel and lubricating oil commingle.

You need to know about STANODIESEL Oil M. In the Midwest, call your nearby Standard Oil lubrication specialist. You will receive the information promptly. Or write Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD

STANDARD OIL COMPANY (Indiana)



Shown are the main steam piping (above) and the boiler-feed-water flow-regulating valves (below) at Pennsylvania Power & Light Company's Martins Creek Steam Electric Station, Martins Creek, Pa.—another installation of K&M Insulations, saving heat . . . saving fuel . . . saving money.

Is your present insulation still efficient?

HIGHER TEMPERATURES CALL FOR HEAT-SAVING K&M INSULATIONS

If operating temperatures have been increased in your plant, insulations that formerly were adequate may now be costing you many dollars in heat losses every day. As fuel costs rise, heat losses become an ever-increasing expense. For important savings in fuel, heat, and dollars, install K&M high pressure insulations—acclaimed for years for efficient heat conservation.

K&M "Featherweight"® 85% Magnesia and K&M Hy-Temp Insulations last the life of the equipment they serve. They withstand moisture, vibration, frequent temperature changes. "Featherweight" efficiently insulates piping and equipment at temperatures to 600° F. For efficiency to 1900° F., Hy-Temp and "Featherweight" are applied in combination, with staggered joints. This eliminates the heat loss that normally occurs in single-layer installations when expansion causes joints to open.

Where moisture is a problem, K&M "Featherweight" Water-Resistant Magnesia Insulation is especially effective. It is used where temperatures rise to 450° F.

Check your operating temperatures, then contact your K&M distributor—an experienced applicator—for details about the heat-saving K&M insulations your plant should have. Or write directly to us.

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

K&M best in asbestos®

In Canada: Atlas Asbestos Company, Limited; Montreal, Toronto, Winnipeg and Vancouver

NEW DIMENSIONS IN CENTRALIZED CONTROL

Two story benchboard controls giant multiple fuel cyclone fired boiler!

The 125,000 KW extension to Raritan River Plant of Jersey Central Power and Light Company can be operated entirely from the compact benchboard shown here. This console, built by Hays and designed by Burns and Roe, Inc., consolidates the necessary control stations and miniature indicators in a small space yet provides easy accessibility for servicing.

In addition, this new design two story benchboard reduces costs three ways:

Lower operating costs—fewer men operate more equipment.

Lower installation costs—entire board fabricated by Hays. Minimum field piping and wiring.

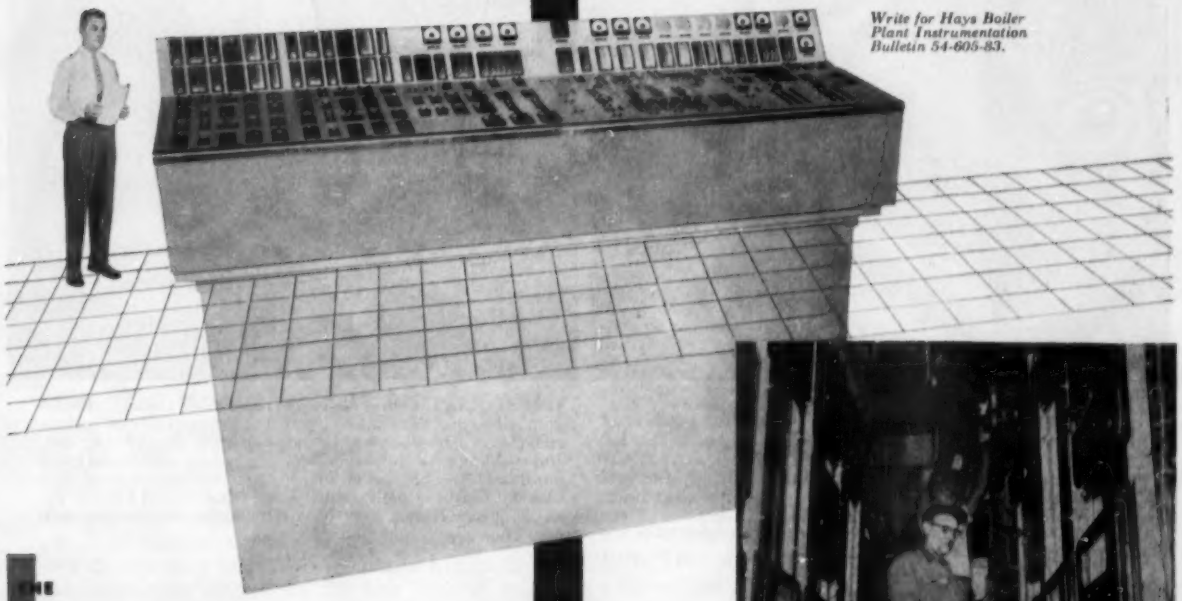
Lower maintenance costs—easy accessibility for maintenance from *inside* the panel (photo below).

Four cyclone furnaces are employed by the pressurized steam generator to deliver 900,000 lbs/hr. of main steam at 2,000 psig, 1050° F. and 740,000 lbs/hr. of reheat steam at 430 psig, 1000° F. The boiler is designed to burn coal and gas in any combination in all cyclones.

A Hays electrically operated combustion control system was selected by Jersey Central. Its electric operation eliminates the need for expensive compressors and dryers and allows maximum flexibility in central control location. Provision has been made in the system for future addition of oil as a third fuel with no loss in flexibility.

Hays paramagnetic type O_2 analyzers with new design sampling systems and electronic recorders are used for oxygen compensation of the control system.

Write for Hays Boiler Plant Instrumentation Bulletin 54-605-83.



Inside view of panel

THE **hays** CORPORATION
Michigan City 3, Indiana

Automatic Combustion Control • Ver-I-Flow Meters and Veritrol • Electronic Oxygen Recorders • CO_2 Recorders Boiler Panels • Gas Analyzers • Combustion Test Sets Draft Gages • Electronic Flowmeters • Miniature Remote Indicators • Electronic Feed Water Controls

Another Norton Rx *on the job!*

Power plant remedies inadequate boiler protection by switching to CRYSTOLON armor blocks*

Walls of water tube boilers were trouble spots in the modern plant of the Rural Cooperative Power Association in Elk River, Minnesota. This photo shows how the previously used refractory material broke down, after comparatively short service, under chemical attack by accumulated fly ash. Results of this inadequate refractory protection were inefficient heat transfer, low-capacity boiler operation and costly shut-downs for repairs. Compare this picture with the one at the right, taken at the same plant.

CRYSTOLON armor blocks provided the Rx. Photographed a year after installation, these rugged silicon carbide refractories look like new. Withstanding the attacks of fly ash, and enabling easy removal of slag, they reduce maintenance and downtime. And because of their high thermal conductivity they transmit heat uniformly to the boiler tubes — still another example of how Norton CRYSTOLON refractories provide maximum protection *plus* conduction.

Norton CRYSTOLON refractories, *engineered and prescribed* for better boiler performance, are characterized by exceptional hot strength, high refractoriness and thermal conductivity. They withstand the mechanical and chemical attacks of a wide variety of fuels and have great resistance to slag penetration, spalling and abrasion.

Get further facts on how these or other Norton refractories can supply money-saving Rx's for your own boiler operations. Ask your Norton Representative for a copy of *Refractories for Heat and Power*. Or write to NORTON COMPANY, 451 New Bond Street, Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto 5, Ontario.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

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REFRACTORIES
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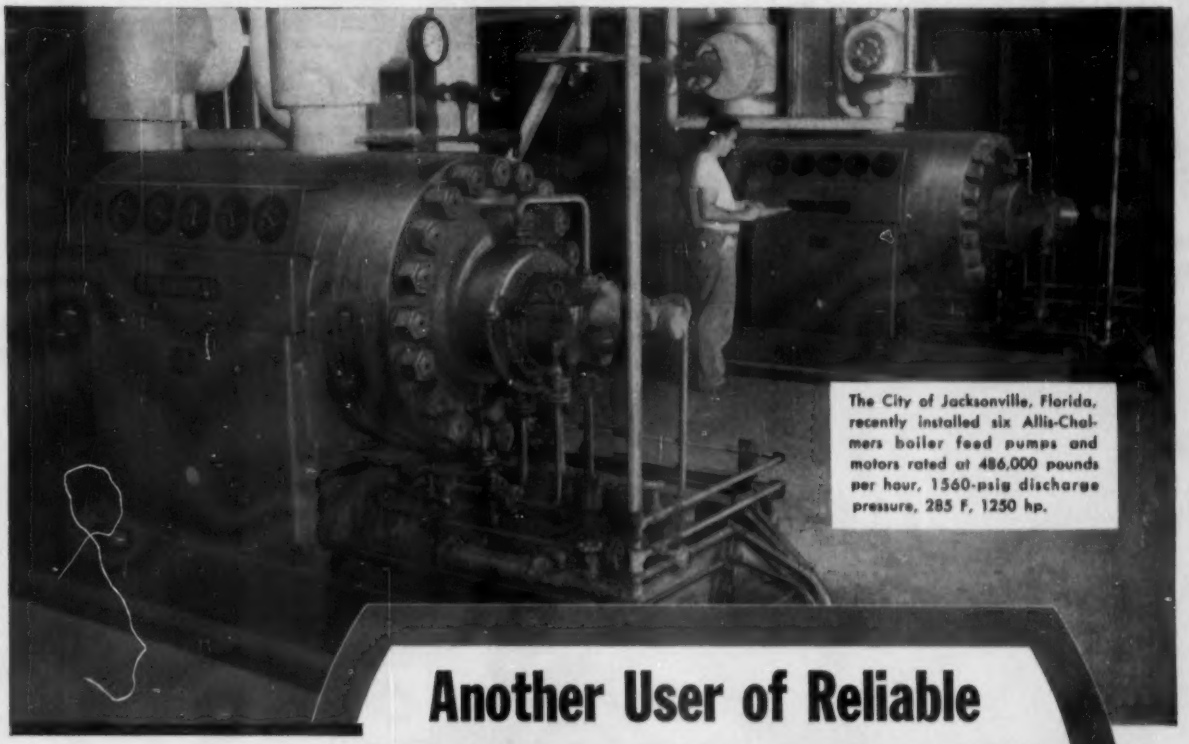
Making better products... to make your products better



The City of Jacksonville, Florida, recently installed six Allis-Chalmers boiler feed pumps and motors rated at 486,000 pounds per hour, 1560-psig discharge pressure, 285 F, 1250 hp.

Another User of Reliable ALLIS-CHALMERS barrel-type PUMPS

City of Jacksonville

Here are the reasons **for wide acceptance of these pumps:**

- Outstanding performance — fully proved by service records.
- High efficiency and smooth operation under fluctuating loads — first stage has twin, single-suction impellers for low NPSH requirements.
- Simple maintenance—expansion joint and shaft seals are brought to outside of pump where they can be easily inspected.
- No balancing device needed—axial balance is maintained by back-to-back mounting of the impellers.

THERE are outstanding features like these throughout the Allis-Chalmers line. Whether you require boiler feed, condensate, circulating or other power plant pumps — it pays to standardize on Allis-Chalmers.

In addition, A-C can supply pumps, motors and control of coordinated design and manufacture. This means one responsibility — one guarantee of satisfaction.

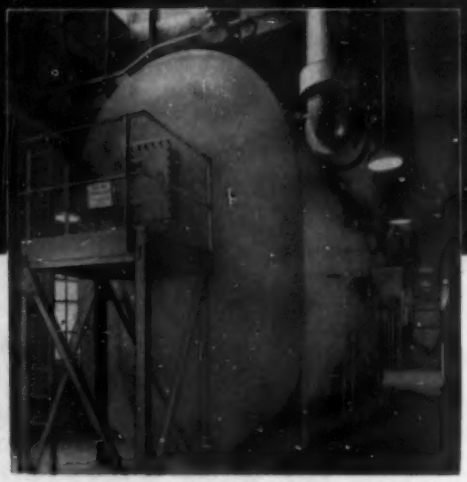
Get complete information on barrel-type boiler feed pumps. Call your nearby A-C office or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin for Bulletin 08B7899.

A-4854

ALLIS-CHALMERS

problems in water-conditioning . . .

COMPLETE DEAERATION



Cochrane
Deaerating Efficiency
produces "ZERO OXYGEN!"

The guaranteed completeness and dependability of Cochrane physical deaeration is unsurpassed!

Cochrane pioneered in this field and today has the largest number of deaerator installations in the world. Cochrane's background in deaeration is your assurance that *guarantees will be met!*

Cochrane Corporation designs and manufactures complete lines of deaeration, precipitation, ion exchange and water conditioning equipment. This *complete* service provides single responsibility for engineering, fabrication and continued satisfaction. Consult Cochrane first . . .

For further information on Cochrane Deaerators, write for literature.

COCHRANE DEAERATOR IN A LARGE UTILITY

This giant Cochrane Deaerator, installed in one of the country's largest utilities, has been meeting guarantees for ten years. Special elliptical design was dictated by space limitations. With a capacity of 1,900,000 lbs. per hour, condensate is deaerated to zero (0.005 cc per liter or less) before being fed to high pressure boilers.

COCHRANE CORPORATION · WATER ENGINEERS SINCE 1863 · PHILADELPHIA

Cochrane
CORPORATION

Representatives in 30 principal cities in U.S.; Toronto, Canada; Paris, France; La Spezia, Italy; Mexico City, Mexico; Havana, Cuba; Caracas, Venezuela; San Juan, Puerto Rico; Honolulu, Hawaii.
Pottstown Metal Products Division—Custom built carbon steel and alloy products

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Demineralizers • Hot Process Softeners • Hot Zeolite Softeners • Dealkalizers • Reactors • Deaerators • Continuous Blowoff Systems • Condensate Return Systems • Specialties

LOUIS N ROWLEY, EDITOR · DECEMBER 1955 · ESTABLISHED 1882 **Power**

No get-rich-quick in atom stocks

RECENTLY I've talked quite a bit about nuclear energy on this page—trying to glimpse the outlines of what it will mean to power-service men in years to come. This month I'd like to depart from our usual concern with long-range technical aspects and speak frankly about some immediate and personal problems growing directly out of the tremendous public interest in this new field.

We've all read of the fast and furious speculation in the "penny" uranium stocks. There'll be some money made, and a lot more will be lost. But dabbling in mining shares is known to be risky and a loser in that kind of game can't cry too hard—he should know the chances he's taking and be prepared for the outcome, good or bad.

The real cause for concern, I think, lies in what happens to the common stock of a manufacturing company when word gets around that they're "getting into atomics." A mere formal announcement of a contract for nuclear equipment, or of a new atomic department, is enough to start a wave of buying. As a Wall Street wisecrack puts it, "hiring a nuclear physicist is good for five points any day." To many stock buyers, the very idea of atomic energy has come to stand for quick profits.

Now there are some things we should think straight about if we're investing savings by purchase of shares in American industry. Here's the way I see these fundamental facts:

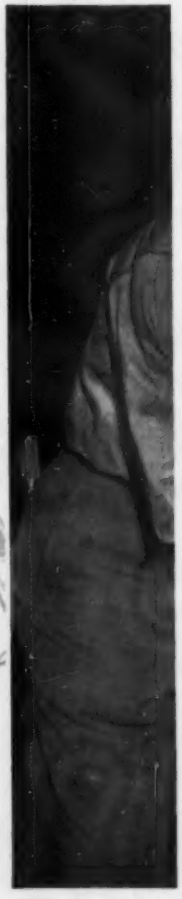
The nuclear field has great potential importance for many companies. For them, participation in this area of industrial activity is a wise and far-sighted move. Their managements have made the decision to enter the nuclear field on the strength of long-range considerations. They see future opportunities for new business, or a means of protecting the company's present interests.

The important word here is *future*. With a few exceptions—makers of Geiger counters are an obvious example—there will be no quick profits in the nuclear equipment field. Quite the reverse, and power engineers should be first to understand the reasons.

Nuclear energy is in a development period—a time when company managers must invest capital without expectation of immediate return. Willingly and wisely, they are buying now the experience and know-how on which future success will rest.

The conclusion, I think, is clear. When you're considering buying a company's common stock, by all means take account of its position in the nuclear field. But put this factor into perspective with all the others. If it's a natural direction for the company's development, see it as a sign of forward-looking management, building for the future. Only the unthinking investor can picture a company's entrance into the nuclear field as a royal road to quick and assured profits.

"When our main feeder single-phased, we did not lose a motor — FUSETRON DUAL-ELEMENT FUSES saved them"



"In October, 1952, we had quite a demonstration on how Fusetron dual-element fuses can prevent motor burn outs.

"Fusetron fuses that we were using to back up our motor protection began popping out all over the plant because our main feeder circuit had single-phased.

"Before we could dump the whole plant by pulling the main switch, sixty-seven Fusetron fuses had opened.

"We did not lose a single motor, however, and while it was some trouble to us to replace all the blown Fusetron fuses, we would rather do that than repair one burned out motor.

"We are convinced that Fusetron fuses used to back up our other motor protection, give us a distinct advantage in saving time and money.

Samuel T. Craig CHIEF ELECTRICAL ENGINEER
JUDSON L. THOMSON MANUFACTURING CO.
WALTHAM, MASSACHUSETTS

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. . . *They provide 10 Point Protection*

1. High interrupting capacity — protect against heaviest short-circuits. Have proven on tests to open safely on circuits set to deliver in excess of 100,000 amperes.

2. Protect against needless blows caused by excessive heating — lesser resistance results in cooler operation.

3. Protect against needless blows caused by harmless overloads.

4. Provide thermal protection — for panels and switches against damage from heating due to poor contact.

5. Protect against waste of space and money — permit use of proper size switches and panels.

6. Protect motors against burnout from overloads.

7. Give DOUBLE burnout protection to large motors — without extra cost.

8. Protect motors against burnout due to single phasing.

9. Make protection of small motors simple and inexpensive.

10. Protect coils, transformers and solenoids against burnout.

AND FUSETRON FUSES REMAIN SAFE

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Once properly installed, Fusetron fuses require no costly inspection time or maintenance necessary on mechanically operated devices.

Dust, fumes, corrosion or age cannot prevent a Fusetron fuse from opening safely. There are no hinges, pivots or contacts to stick or slow down the operation of the fuse on short-circuit.

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Blowing time charts and more information are available on Fusetron dual-element fuses. Write for bulletin FIS.

FOR LOADS ABOVE 600 AND UP TO 5,000 AMPS . . . Use BUSS Hi-Cap Fuses

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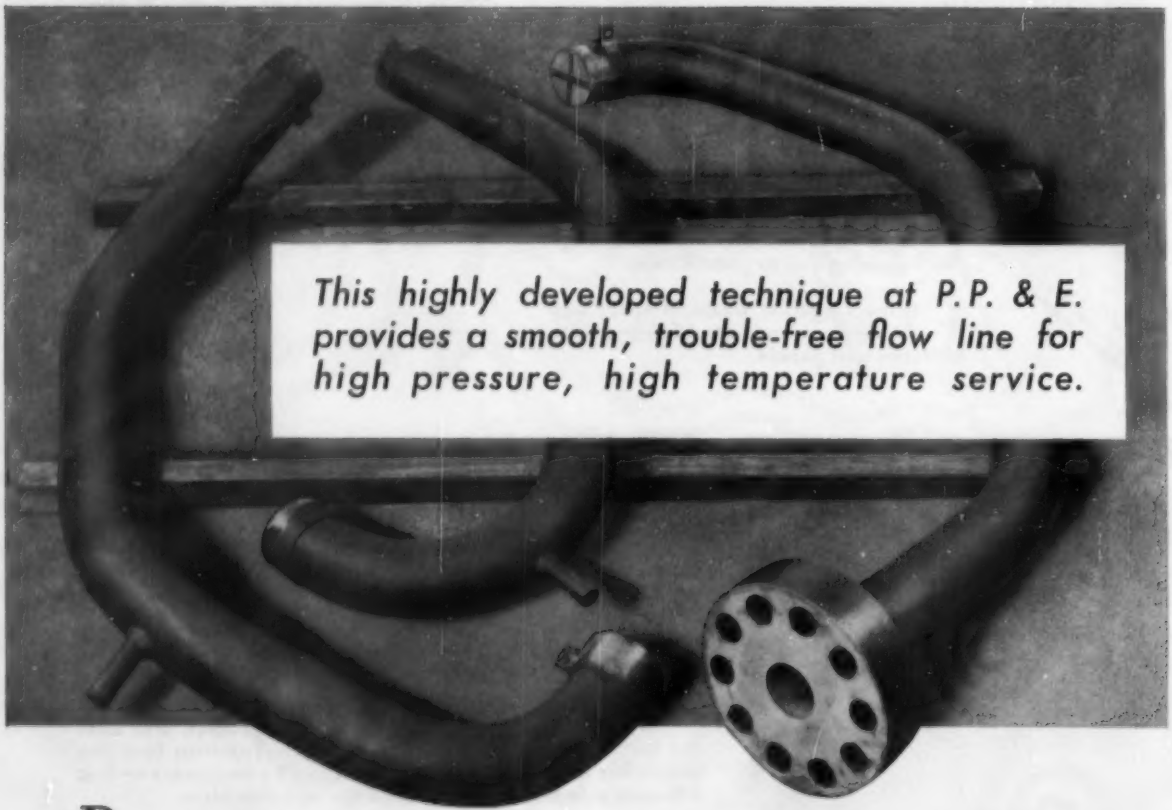

This highly developed technique at P.P. & E. provides a smooth, trouble-free flow line for high pressure, high temperature service.

Bending heavy wall piping is an art which provides a pipe line having best flow characteristics, with turbulence held to a minimum.

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PP-14

Nuclear Energy Today

By **L N ROWLEY**, Editor, and

B G A SKROTZKI, Associate Editor

Pictured here is the reactor core cage of the 60,000-kw installation now under way at Shippingport, Pa. It symbolizes an important fact—nuclear plants are taking concrete form, will soon be feeding kwhr into major utility systems. Thus it seems a good time to see where this new energy source stands today and what the future holds.

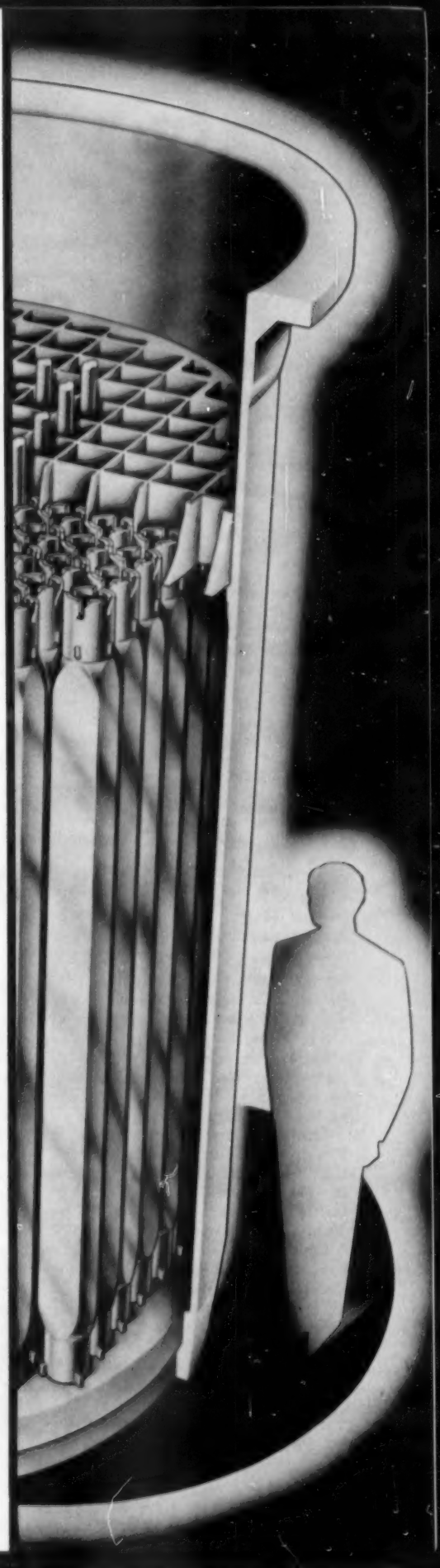
This special report does just that. After a brief review of fundamentals it plunges directly into a roundup of developmental and commercial-scale nuclear projects — what the equipment looks like, what advantages are claimed for various designs, what problems remain.

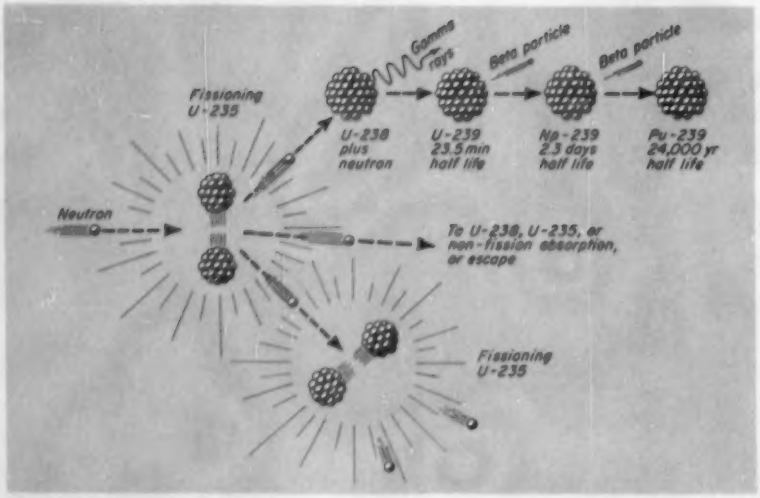
This, then, is the nuclear-energy picture at year end 1955 — as we move out of the laboratory and experimental phase into what might be called the "hardware" stage. From the experience gained with these plants, and with others just a gleam in some reactor designer's eye, will come the economically competitive nuclear plants of the future. Keep this in mind when you study and compare these fledgling plants and remember as well that the nuclear-energy field is a young fast-moving one.

a **Power** special report

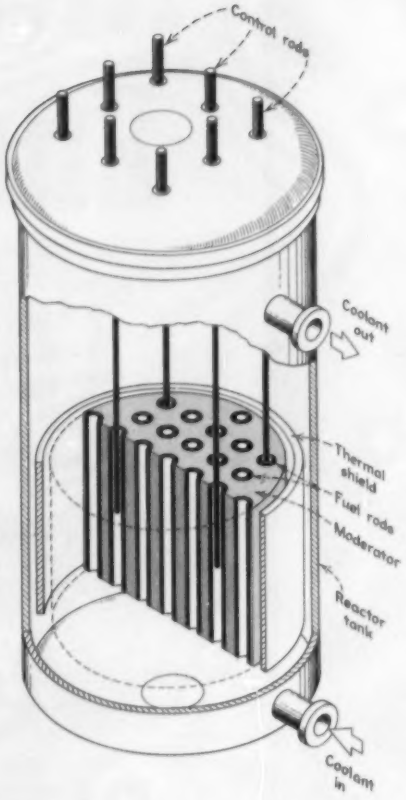
TYLER HICKS, *Special Projects Editor*

DECEMBER, 1955





NEUTRONS MAKE CHAIN REACTION work in successive fissioning of U-235 nuclei, convert U-238 to fissionable Pu-239. Each fission produces 2½ neutron average



THERMAL REACTOR uses moderator to slow high-speed neutrons, raise reactions

How nuclear reactors work

All the heat we use comes from converting solid matter to energy. The amount of matter that disappears as energy in our ordinary fires weighs so little that we never miss it. For instance, one pound of any kind of matter equals a total of 11.3 billion kwhr or 38.6 trillion Btu of energy.

This means that when we get 14,000 Btu from burning a pound of coal, less than one billionth of a pound of the coal disappears in converting to the heat produced. No wonder we never are aware of this process.

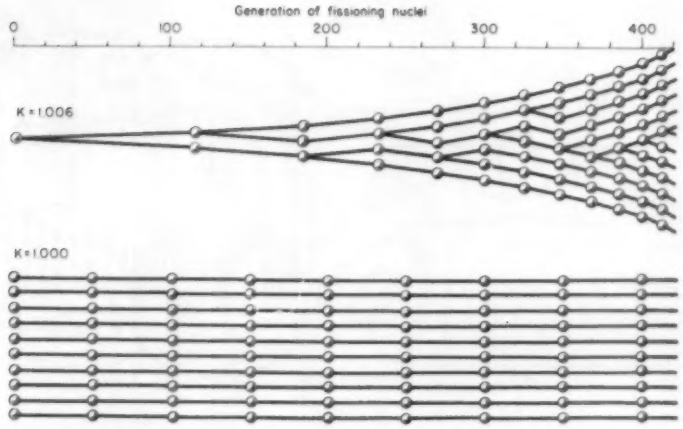
Combustion vs fission. Ordinary burning involves only changes in the electrons of the elements reacting in the fire. The molecules of fuel and air rearrange themselves to form other molecules which we know as combustion products, and in the process change an insignificant amount of their mass to energy.

In a nuclear reactor, however, we split or *fission* the nuclei of certain atoms to convert about 1/1090 of their mass to heat energy. The original elements that fission change into completely different elements, something that doesn't happen in our ordinary fires. Let's see how we go about fissioning atoms.

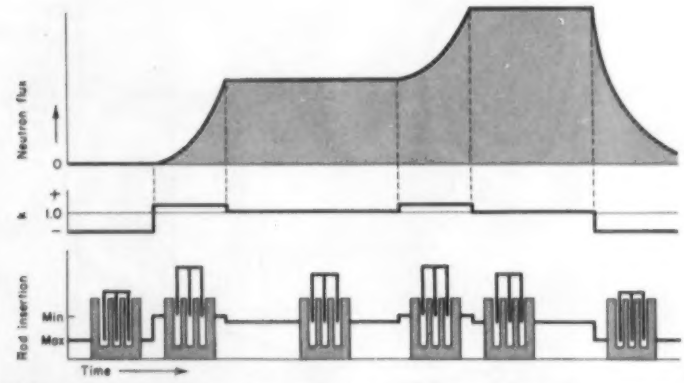
Heat production. A neutron hitting and entering the nucleus of a U-235 atom, as in the picture, *above left*, carries with it enough energy to upset the internal balance of forces between the protons and neutrons of the nucleus. This makes the *excited* U-235 atom fission into two unequal fragments. These fragments are even more unbalanced than the original U-235 atom and they immediately eject high-speed neutrons. On the average each fission releases 2½ neutrons.

The fragments fly away from each other at high speeds also, but they slam into neighboring atoms and cause them to vibrate more, producing what we call heat. After giving up their high-speed kinetic energy in this way, the fragments themselves slow down to stop and vibrate as heat somewhere in the mass of fissionable material.

Nuclear fuels. The high-speed neutrons released by the fission fragments are important in the working of a reactor. They (1) cause other atoms to fission and (2) convert fertile materials into fissionable materials. Both processes are shown in the picture above. The only materials that can fission easily are U-233, U-235 and Pu-239 (plutonium). U-233 is made from thorium by hitting the atom nuclei with neutrons. U-235 is found as 0.7% of natural uranium, the other 99.3% consists of U-238 (which can be fissioned to a small degree by high-speed neutrons). Plutonium is made from U-238 by adding a neutron, *picture above*, and letting a decay process take



CHAIN REACTIONS *can be made to grow, top, stay at constant level, bottom, or peter out, reverse of top. Each ball represents neutron causing atom to fission*



REACTOR HEAT-GENERATION *rate depends on size of neutron flux, regulated by moving neutron-absorbing control rods in and out of reactor core to vary k value*

place during which the excited nucleus transforms to its "final" state after emitting gamma and beta radiations. The highly excited fission fragments also give off gamma, beta and alpha radiations while decaying to a more stable state. This activity makes it important to shield reactors so people in the area do not receive lethal doses.

Chain reaction. When we gather enough fissionable material in a reactor core to form a *critical mass* so that at least one neutron from each fission causes another atom to fission we have a *chain reaction.* If we can hold this condition, a steady flow of heat is produced. If less than one neutron per fission produces another fission, the chain reaction grinds to a halt. If we get more than one neutron per fission causing other fissions our rate of heat production steadily rises. If this happens fast we have a bomb.

The chain reaction diagram, *above,* shows the conditions for (1) steady heat production and (2) for increasing production. A multiplication factor k tells us how a chain reaction progresses. Value of k is the ratio of the number of neutrons in one generation to the number in the immediately preceding generation. The top diagram, *above,* shows how one neutron in the first generation of a chain reaction has many descendants 400 generations later, when k=1.006. It takes only a fraction of a second for this growth to occur.

The lower part of the diagram shows how a group of neutrons each produce a series of single neutrons in succeeding generations when k=1.000. This constant chain reaction produces a constant rate of heat output. To lower the rate of neutron production we must drop k below 1.0. This produces fewer neutrons in succeeding generations, like going from right to left in the diagram for k=1.006. This would be about equal to k=0.994.

Control. At constant heat output, only one neutron per fission must cause another fission. Since each fission produces 2½ neutrons there is an excess of 1½ neutrons per fission. Designers must do a careful job to bring waste absorption and leakage of neutrons below 1½ in reactors. Whatever excess of neutrons is left is soaked up by moving control rods in the reactor core.

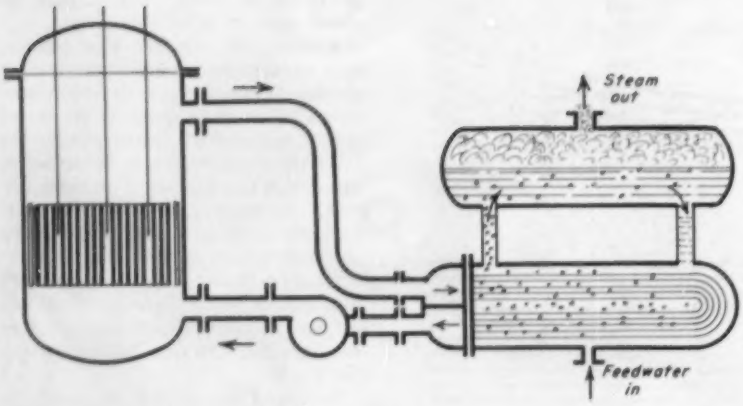
Diagram, lower left, *this page,* shows how control rods are moved in and out of the core to soak up more or less excess neutrons to vary k and resulting *neutron flux.*

To load the reactor from shutdown conditions, the control rods are pulled out slowly until k is greater than one. The neutron flux and heat output grow until the desired level is reached. The control rods are then quickly inserted to keep k at exactly 1. To raise the output the rods are again pulled out, making k greater than 1. As soon as the new output level is reached, the rods are again pushed back to k=1.

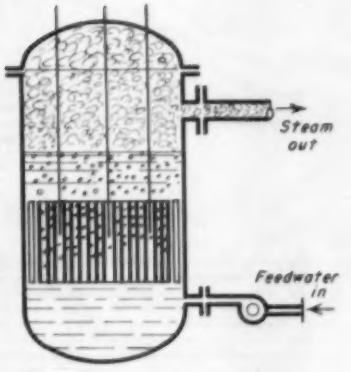
To shut down the reactor the rods are simply pushed in all the way. The rods then help soak up more than the 1½ excess neutrons per fission and the flux and heat production quickly taper off to a low value. Heat production continues for some time after shutdown because of the radioactivity in the core. This heat must be removed to prevent damaging the core.

Reactor parts. Let's take a quick look at the elements of a reactor. Top right, *facing page,* shows a diagrammatic layout of a thermal reactor. Hollow fuel rods of natural uranium are surrounded by a moderator—let's assume here it's pure graphite. The moderator slows down the high-speed neutrons leaving the fissioning U-235 to a speed comparable with that of gas molecules at moderate temperatures. At these low *thermal* speeds the neutrons stand a much better chance of being absorbed by U-235 nuclei to cause fission.

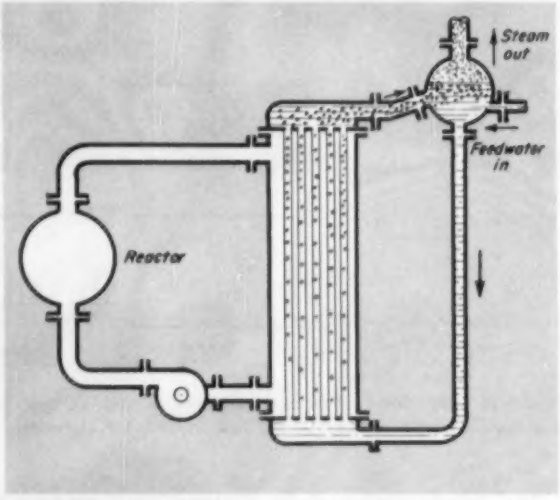
The coolant enters the bottom of the reactor tank to flow up through the hollow centers of the fuel rods. The coolant carries off the heat generated in the fuel rods and leaves the reactor tank through the upper nozzle. The control rods can move up and down in the center of some of the fuel rods to vary the value of k. The coolant also flows in the annular space between control rod and fuel rod. The thermal shield absorbs much of the radiation and neutron energy leaking from the core. Metal or concrete biological shielding (not shown) surrounds reactor tank, protects plant personnel.



PRESSURIZED WATER REACTOR has pump circulate water between reactor tank and boiler. Coolant also acts as moderator in natural or slightly enriched core



BOILING-WATER REACTOR produces steam in water-moderated enriched core



HOMOGENEOUS REACTOR circulates fluid bearing fuel between reactor and boiler. Critical mass in reactor heats fluid

Reactor types. About 150 designs have been proposed for steam-generating power reactors. We will look at just a few to understand the basic principles. Thermal reactors use moderators to slow the high-speed neutrons to a level where they react more readily to fission U-235. Such reactors, fueled with natural uranium or uranium slightly enriched with U-235, must use moderators. On the other hand, fast reactors fueled mostly with U-235 need no moderators.

In addition to graphite, we can use heavy water as a moderator for natural uranium, or light water for enriched uranium. Thus, water can do double duty—act as (1) moderator and (2) as a coolant to carry heat out of the reactor core.

Pressurized water reactor (PWR), *upper left diagram*, is designed to prevent boiling of the water coolant in the core. A pump circulates the water in the coolant loop between reactor tank and boiler. The coolant picks up heat in the core and gives it up in the boiler. The boiler has two sections (1) heat exchanger and (2) steam drum.

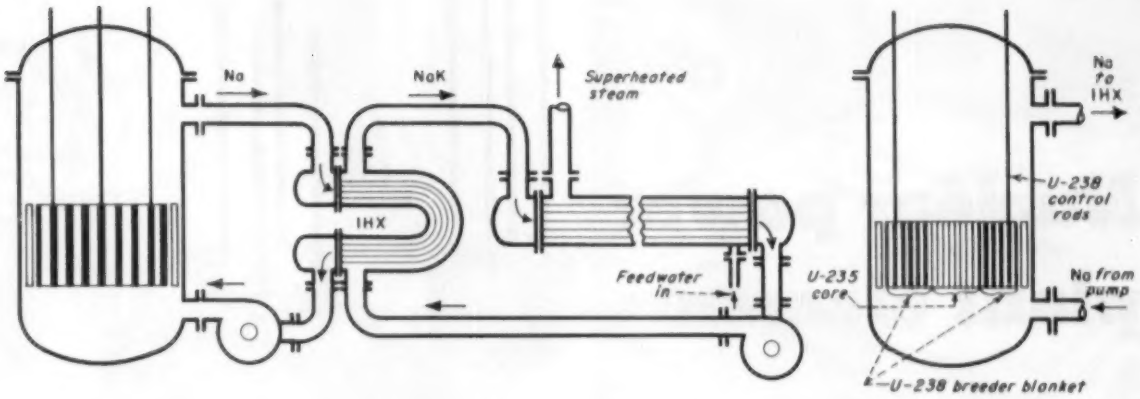
Boiling-water reactor, *upper right*, eliminates the coolant loop of the PWR. The coolant (which is also the moderator) picks up heat in the reactor core to form steam bubbles. The bubbles separate from the water at the water level and the steam leaves through the upper reactor-tank nozzle. Feedwater enters the reactor tank below to pass up through the fuel elements in the core as coolant and moderator. Steam leaving the reactor will be moderately radioactive—so steam equipment must be shielded.

Sodium-graphite reactor, *upper left, facing page*, uses graphite as a moderator and liquid-metal sodium (Na) as coolant. This permits reaching high coolant temperatures out of the reactor with moderate pressures of only about 100 psig. Because sodium becomes highly radioactive in the reactor an intermediate heat exchanger must be used between reactor and boiler.

The sodium gives up its heat load to another liquid metal, sodium-potassium (NaK), in the intermediate heat exchanger, IHX. The NaK carries the heat at high temperature to the boiler. This boiler may be of the once-through type where the feedwater enters at one end and leaves as superheated steam at the other. Each coolant loop has its own pump.

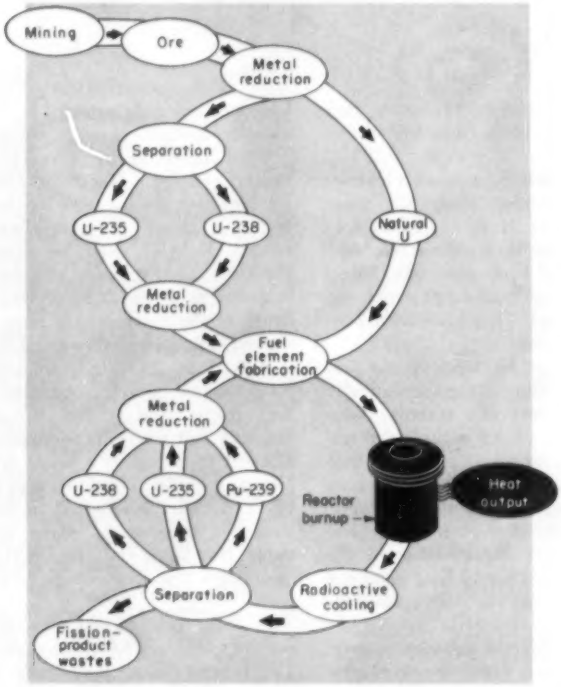
Fast breeder reactor, *upper right, facing page*, has no moderator, uses 90% U-235 in reactor core, and is liquid-metal cooled. High-speed neutrons fission the U-235 in the compact core and the excess neutrons convert fertile material in the blanket surrounding the core to fissionable isotopes. Like the sodium-graphite reactor, this unit also needs two coolant circuits and an IHX.

The control rods in one unit are made of U-238, instead of being of neutron-absorbing "poison". They control leakage of neutrons out of core.



SODIUM-GRAPHITE REACTOR uses two liquid-metal coolant circuits with intermediate heat exchanger to avoid making steam radioactive in once-through boiler

FAST BREEDER REACTOR has U-235 core, U-238 blanket, liquid-metal coolant



URANIUM FUEL PREPARATION involves original processing of ore to fuel elements, reprocessing of spent fuel elements

Homogeneous reactor, *center, facing page,* uses fissionable material carried in a liquid. The fissionable material may be (1) a sulphate of uranium dissolved in light or heavy water (2) an oxide of uranium carried as a slurry in water, or (3) a solution of uranium in liquid bismuth.

The pump passes the liquid bearing uranium (in some form) into the reactor which simply slows up the flowing uranium to a continually changing critical mass. Fissioning U-235 moderated by the water heats the solution. The heated solution passes out of the reactor into the boiler to give up its heat load. The pump then passes the cooled solution back to the reactor.

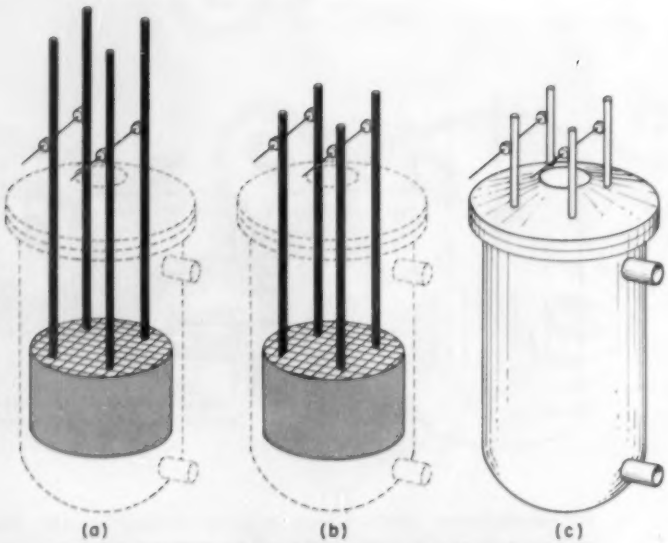
Cycles using water as the carrier must be pressurized to keep the water from boiling. On the other hand, the liquid-metal fuel solution need not be pressurized, but must have a graphite moderator in the reactor vessel. Potential ability to carry on fuel processing to remove fission products while the reactor is under load offers an advantage. Such processing would be carried on by constantly withdrawing a fraction of the solution flow for poison separation, and injecting fresh fuel.

Fuel preparation, *diagram left,* starts with mining the original ore. Mostly standard metallurgical processes reduce the ore to uranium metal ingot. The ingot may be fabricated into fuel elements directly or first pass through a physical process to separate fissionable and fertile isotopes. The U-235 may be used to enrich normal uranium or be made into fuel assemblies. U-238 assemblies would be used in a reactor as fertile material for conversion to plutonium.

Fissioning of fuel assemblies in the reactor produces the end product, heat, but also creates poisons out of the split fuel atoms. The percentage of fuel atoms used in "burnup" runs about 1% for natural uranium and about 14% for U-235 fast reactors. This means there will be from 86 to 99% of unused uranium and plutonium in the spent fuel assemblies that should be recovered.

Both chemical and physical processes separate radioactive poisons from plutonium and uranium, which may be refabricated into fuel elements.

Nuclear power plant elements



PRIMARY PROTECTION against reactor accident uses scram control rods. Reactor tank must hold gases of melting core

In a nuclear power plant, the reactor and its coolant circuit replaces the steam boiler of a conventional power plant. As you might suspect from the elementary circuits shown on the previous pages, the nuclear reactor has auxiliaries like other main power equipment. The auxiliaries have familiar forms and parts—but some have radically new designs and jobs.

One of the striking features of nuclear plants will be large tanks or containment vessels completely sealing the reactor and the coolant circuit. These guard against radioactive gases from a reactor or coolant-circuit accident spreading through the plant and vicinity.

Reactor accident. If the coolant system should fail to remove heat from the reactor core, the latter would overheat and melt. This event can be guarded against by quickly inserting "scram" control rods to stop the chain reaction and shut down the reactor, *diagram above*, whenever core temperature rises above a safe level.

If the control rods fail, the reactor will melt. After the fuel elements distort, the core breaks apart enough to stop the chain reaction. But the radioactive gases produced by the melting must be held inside the reactor tank to prevent contaminating the plant.

If the reactor tank should rupture after an accident in the core, or if the coolant circuit leaks badly, the gases and radioactive vapor will leak out under pressure. They can be held in a containment shell completely sealing the reactor and auxiliaries, *top left, facing page*. The shell must hold the gases under whatever pressure they have after expanding from the reactor tank.

As a final protection against leakage of the containment shell, the plant could be placed in an exclusion area large enough so that radioactive fallout would land in it, *top right, facing page*. It appears that large areas will not be specified for plants with adequate containment.

Reactor parts. Sketches on the preceding pages show diagrammatically the principal parts of a reactor. Later pages show details of actual reactors. Fuel elements are usually built up into rod assemblies. The elements may consist of plates, rods, tubes, pellets, etc, arranged so that coolant can flow over their length. All sections of the fuel element are thin so heat need not travel far in the metal to the surrounding coolant.

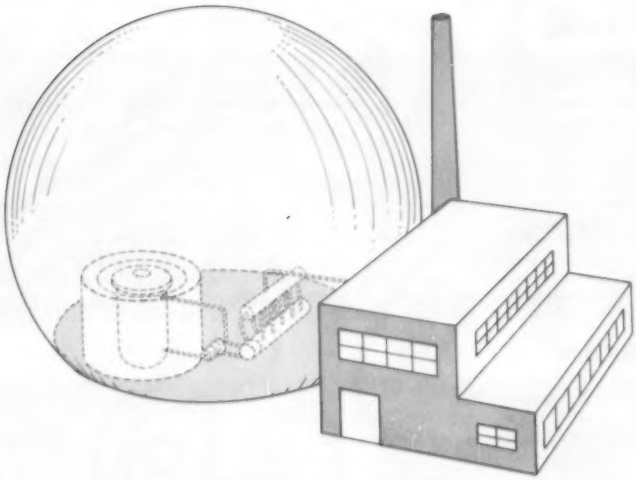
Because uranium corrodes easily, especially under high temperatures, the fuel elements must be completely clad with zirconium, stainless steel, aluminum or some corrosion-resistant material. Another important reason for canning or cladding fuel elements arises from the radioactive gases that fissioning also produces. These must not be allowed to enter the coolant flow.

The fuel assemblies are held in place by a grid or core cage supported inside the reactor tank. They must be close enough to form a critical mass with enough reactivity to have a life of several months to several years. Despite this relatively long life, fuel assemblies may have to be shifted about, because fissioning activity is not necessarily uniform throughout the core.

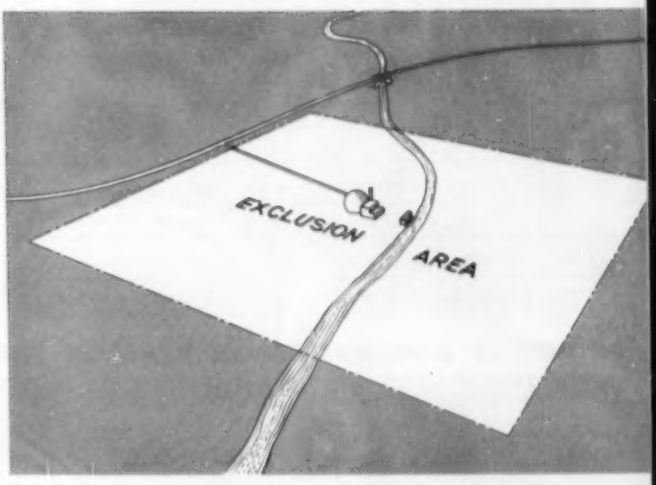
Fuel handling for a reactor poses special problems. To put a fresh fuel element into the core, the reactor must be shut down, depressurized, and cooled. Reactor must be completely flooded so that the core of small units is under at least 12 ft of water. The cover of the reactor tank must be removed. The radioactive spent-fuel assembly must be lifted out with long tongs by an operator standing above and transported under water to a "cooling" pit where its radioactivity is allowed to decay to a lower level for several months. The fresh fuel assembly can then be inserted in the core vacancy, lowered in place by long tongs. Not being radioactive, the fresh fuel offers few special handling problems.

In large reactors, the fuel assembly may be too heavy for manual handling. The reactor tank may have special fuel-handling ports in the cover. A long narrow lead-lined flask carried vertically by an overhead crane would be connected to the fuel port of the cooled, depressurized reactor vessel. Mechanical tongs in the flask would reach into the reactor core and withdraw a spent fuel assembly up into the flask. The crane would then transport the flask to the cooling pit to discharge the fuel. Then the crane charges the flask with a fresh fuel element, inserting it into the reactor. Most likely the flask could hold several fuel assemblies at once, to limit moves.

Shielding of a reactor takes several forms. Some reactors have a thermal



SECONDARY PROTECTION of containment tank or shell guards against rupture of reactor vessel or coolant circuit



HIGHEST ORDER PROTECTION uses exclusion area around plant to prevent radioactive fallout on plant neighbors

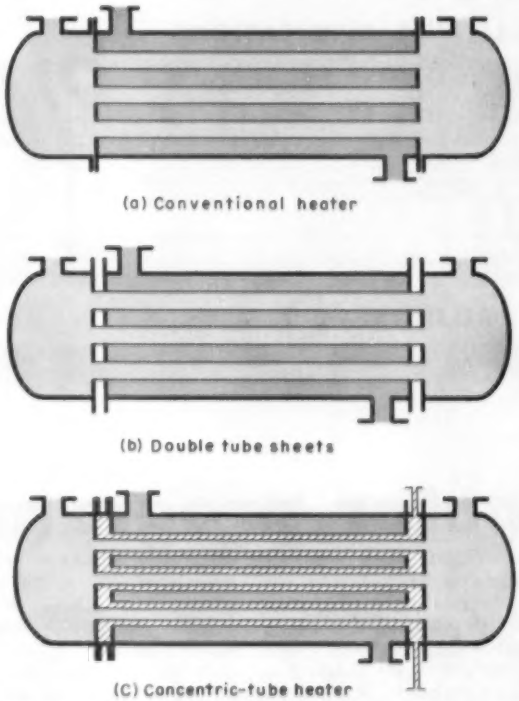
shield between the core and reactor tank. This shield absorbs most of the fast neutrons and some of the gamma radiations that escape from the reactor core. These energy absorptions generate heat in the shield. Part of the coolant flows over the shield surface to remove the heat, and itself acts as a shield.

Gamma radiations have high penetrating power, coupled with lethal effects on living tissue. So the reactor tank must be completely surrounded by a biological shield of high-density concrete at least several feet thick. The latter may be air cooled. Alternatively this shield may be of high density metal considerably thinner than concrete for equal effectiveness.

Heat exchangers in the coolant circuits handling radioactive fluids, or both liquid metal and water, must be made as internally leakproof as possible. Conventional heaters, *diagram a, right,* have potential leakage points at the tube-sheet joints. Seal welding these joints guards against leakage here but not against holes caused by corrosion.

Another way to avoid mixing fluids at tube joints uses double tube sheets, *diagram b.* Leakage shows up as a drip from between tube sheets. This would be undesirable with liquid metals reacting with air.

Best and most expensive way uses concentric tubes, *diagram c.* A third fluid between tubes and sheets is inert to other two fluids. Holding third fluid at intermediate pressure to both shell and tube fluids permits leak to be detected immediately by pressure change—either an increase or decrease.



HEAT EXCHANGER design (a) lets fluids mix if the tube joints leak, (b) joint leaks show as drip between tube sheets, (c) third fluid at in-between pressure signals internal leak

Coolant pumps handling radioactive fluids should not leak. This has led to design of canned-motor pumps in which fluid acts as lubricant for both pump and motor. Fluid also fills all space between motor rotor and stator but is hermetically sealed in unit to prevent outside leakage. Valves must also be sealed against stem leakage. Some designers feel leakage may be allowed but will be contained in a gathering system.

Electromagnetic pumps to handle liquid metals are being developed. These have no moving parts, depend on mechanical force between magnetic fields to move liquid.

Stationary Power Reactors Currently

FIVE-YEAR REACTOR DEVELOPMENT PROGRAM

Sponsor or owner	Location	Reactor type	Fuel and fertile material	
AEC and North American Aviation, Inc	Santa Susana, Calif.	Sodium-graphite	2.8% enriched uranium	
Atomic Energy Commission	Lemont, Ill.	Boiling water	Slightly enriched uranium	
Atomic Energy Commission	Oak Ridge, Tenn.	Aqueous homogeneous	Uranyl sulfate in heavy water	
Atomic Energy Commission	Arco, Idaho	Fast breeder	Highly enriched U, and U-238	
AEC and Duquesne Light Co	Shippingport, Pa.	Pressurized water	Highly enriched U, and UO_2	

POWER DEMONSTRATION REACTOR PROGRAM

Yankee Atomic Electric Co	Rowe, Mass.	Pressurized water		
Atomic Power Development Associates (Detroit Edison)	Michigan	Fast breeder	Enriched uranium with blanket of depleted uranium	
Consumers Public Power District	Nebraska	Sodium graphite	Slightly enriched uranium	

PRIVATE LICENSE APPLICATIONS

Consolidated Edison Co of N. Y.	Buchanan, N. Y.	Pressurized water	Highly enriched uranium, thorium fertile material	
Nuclear Power Group (Commonwealth Edison)	Near Chicago	Dual-cycle boiling water	Enriched uranium	
Rural Cooperative Power Assn*	Elk River, Minn.	Closed-cycle boiling water	Natural uranium and enriched uranium	
Pennsylvania Power & Light Co		Aqueous homogeneous		

SPECIAL PROJECTS

Army package power reactor	Fort Belvoir, Va.	Pressurized water	Slightly enriched uranium	

*Present status; may receive AEC assistance

Reactor programs

Most of the reactors built and operated to date have been research or experimental units, designed to test nuclear effects on materials or to check the safety and performance of new reactor ideas. And new ideas keep coming along—consider the variety of materials available as fuels, moderators, and coolants, and the number of forms in which they can be used. With so many possibilities, it can be seen that the search for desirable power-reactor types would be a herculean task if each were investigated on a large scale.

AEC policy. Thus the Atomic Energy Commission has followed a policy of wide experimentation in the laboratory and small pilot-plant stage and then selected the most promising types for investigation in larger sizes and possible demonstration in full commercial scale.

In this work, the Commission policy has been to develop advanced technology at government expense, while stimulating outside groups to undertake developmental or demonstration projects with a minimum of AEC financial participation.

Reactor program. This general approach has had two divisions. The 5-year reactor development program is a direct AEC activity, recognizing the Commission's responsibility to develop reactor technology to a point where one or several reactor concepts appear to be technically and economically feasible. The upper part of the table above lists the various projects in the 5-year reactor program.

The second part of the AEC approach is the power demonstration reactor program, an opportunity for private industry to enter the nuclear power business by developing, building and owning nuclear plants.

Industrial participation. While there are some instances of cost-sharing by industry in the 5-year reactor development program, primary financial and technical responsibility rests with AEC. Under the power demonstration program, this responsibility rests with industry. But, recognizing that reactors built with today's knowledge wouldn't be economical or competitive, the Commission offers assistance to industry in several forms: (1) waiver of charges for loan of nuclear material (fuel) for a period up to seven years (2) use of AEC labs for certain research and development work (3) support of research and development work in non-Commission facilities for the resulting information.

Planned Or Under Construction

Moderator	Pressure, psi Primary	Pressure, psi Steam	Steam temp, F	Coolant	Capacity, kw Heat	Capacity, kw Electricity	Reactor developer	Date
Graphite				Liquid sodium	20,000		North American Aviation, Inc	1956
Light water	600	600	Sat.	Light water	20,000	5000	Argonne National Laboratory	1956
Heavy water	2000	520	473	Heavy water	5-10,000		Oak Ridge Nat'l Laboratory	1956
None				Liquid sodium	62,500	15,000	Argonne National Laboratory	1958
Light water	2000	600	Sat.	Light water	230,000	60,000	Westinghouse Electric Corp	1957
Light water				Light water		100,000	Monsanto Chemical Co and Fluor Corp	1958
None		600	730 F	Liquid sodium, NaK secondary	300,000	100,000		1959
Graphite				Liquid sodium		75,000	North American Aviation, Inc	1958
Light water	1500	370	1000 F	Light water		150,000**	Babcock & Wilcox Co	1960
Light water	600	600	Sat.	Light water		180,000	General Electric Co	1960
Light water	1200	600	Sat.	Light water		22,000	AMF Atomics Inc (Div of American Machine & Foundry)	1959
						150,000	Westinghouse Electric Corp	1962
Light water	1200	200	407 F	Light water		1825	Alco Products, Inc	1957

**Approximate reactor output; oil-fired superheater brings total capacity to 236,000 kw

The first invitation to industry to submit proposals under the power-demonstration program was issued in January, 1955. Ground rules under which such proposals would be judged were announced as follows: (1) the probable contribution of the proposed project toward achieving economically competitive power (2) the cost to AEC in funds and materials (3) the risk to be assumed by the maker of the proposal (4) the competence and responsibility of the maker of the proposal (5) assurance given by the maker of the proposal against abandonment of the project. In addition, of course, technical features of the proposal must meet the safety requirements involved in securing a license to build and operate a nuclear plant.

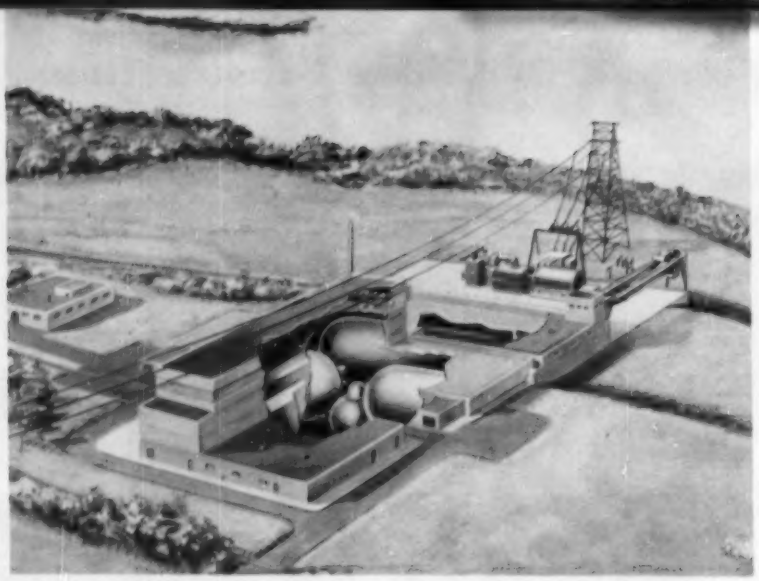
Demonstration units. From this first invitation, AEC received four proposals: from the so called Detroit Edison Group, from the Nuclear Power Group (later withdrawn), from Consumers Public Power District of Nebraska, and from Yankee Atomic Electric Co. The remaining three proposals are listed in the tabulation above. Of these, the AEC has recently announced that the Detroit Edison Group proposal had been found a satisfactory basis on which to negotiate a contract. The remaining two proposals are still under consideration after being modified.

The Nuclear Power Group proposal calls for no assistance from the government and thus was withdrawn from the demonstration program and is being processed as a straight license application. In this category (table above) are the entirely private applications of Consolidated Edison Co of N. Y. and Pennsylvania Power & Light Co.

New invitation recently issued by AEC (Sept 21, 1955) calls for power demonstration reactor proposals in three capacity ranges: 5-10,000; 10-20,000; 20-40,000 kw. As in former invitations, contracts finally negotiated will be "closed-ended"—that is, AEC will provide fixed assistance, without increase should estimated cost of project be exceeded. In the case of proposals for these smaller plants, AEC will consider taking a larger share of cost, possibly paying for and retaining title to all or part of the reactor plant.

In its own 5-year development program, AEC set out to explore five basic reactor concepts: (1) pressurized-water (2) boiling-water (3) sodium-graphite (4) fast-breeder (5) homogeneous. As can be seen in the tabulation above, each of these will be investigated on an essentially commercial scale by projects under the demonstration program and by completely private developments. A look at each of these five main areas of development will give us a pretty good idea of reactor development—this is done in the following pages of this special report.

PWR Plants



SHIPPINGPORT PLANT of Duquesne Light Co, Pa, has its reactor and auxiliaries housed in four containment tanks. Four boilers feed steam to 100-mw turbine

The pressurized-water reactor fueled with slightly-enriched uranium uses light water as both moderator and coolant. This reactor may be classified as a thermal, heterogeneous type. The fuel elements and control rods making up the core mount in a pressure vessel. A pump circulates the water through the core and vessel to an external heat exchanger. These form a closed circuit.

In the heat exchanger the hot pressurized water gives up heat to the steam-power-plant circuit by supplying steam to a turbine-generator. To generate even moderate steam pressures and temperatures—say 600-psig saturated—takes high coolant pressures. This avoids boiling and cavitation in the coolant-circuit components.

Coolant water must be kept highly pure. Impurities may form heat-resistant deposits on fuel elements and can accelerate corrosion. Impurities become radioactive in the reactor and create maintenance problems when they deposit in coolant equipment outside the reactor.

But high-purity water at high temperatures, is itself, a corrosive medium. Materials like zirconium, stainless steel and stellite are used to contain such water. Research now under way may discover materials that will inhibit corrosion for these conditions.

Shippingport Plant. Most of the reactors built in the next few years will be PWR's because their technology is probably the best known. The only full-scale unit in the 5-year reactor development program is of this type and private industry shares in its financing.

The 60-mw plant at Shippingport, Pa., is being erected on a site owned by the Duquesne Light Co. They contribute toward the cost of the reactor, are building the associated electric plant and will buy steam from the reactor at specified rates. Responsibility for reactor-plant development and design rests with Westinghouse Electric Corp. Shippingport will start late in 1957 or early 1958. Much detail has been released on this plant—so let's study it to see what a working nuclear plant looks like.

General layout. As the view above shows, four containment vessels house the reactor and coolant circuits, the boilers and pumps of the four coolant loops, pressurizing tank and auxiliaries. These huge closed tanks will hold any radioactive gases and steam that would be released by a failure in the reactor or any part of the coolant system. Drawing at top of p. 83 shows reactor vessel and two coolant loops.

Reactor core. Sections through the reactor core, *opposite page*, show fuel elements stacked together closely and the cross-shaped control rods. There are two kinds of fuel elements: (1) seed assemblies and (2) blanket assemblies. The 24 seed assemblies consist of 90-95% U-235 alloyed with zirconium. These are arranged in a square. The cross-shaped control rods move up and down within these elements.

Four subassemblies welded together with spacers make up each seed assembly. The subassemblies look like the element in the right side of the top right photo, p 84. The 2000-psig coolant passes through the channels and over all surfaces of the subassembly. All the surfaces of the U-235 zirconium-alloy are clad with Zircaloy-2 to guard against corrosion.

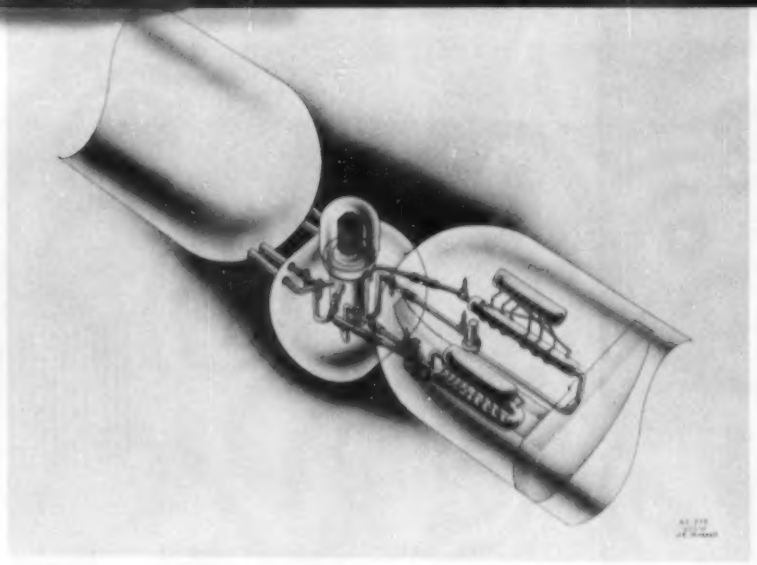
The blanket assemblies fill the space inside and outside the square formed by the seed assemblies. Zircaloy-2 tubes filled with UO_2 pellets make up the blanket assemblies. Each blanket is a stack of 7 bundles of 100 tubes. Top right photo, p 84, shows one bundle held together by endplates. The 2000-psig water flows up through the holes in the endplates to cover the UO_2-filled tubes.

All the fuel elements lock into the bottom support plate and the upper grid. The 2000-psig water enters the bottom of the reactor vessel to disperse upward through the flow baffle into the fuel elements. About 10% of the water bypasses the core to cool the vessel wall and thermal shield. The water itself contributes to shielding effect at this area. Water enters at 508 F and leaves at 542 F through four individual coolant loops.

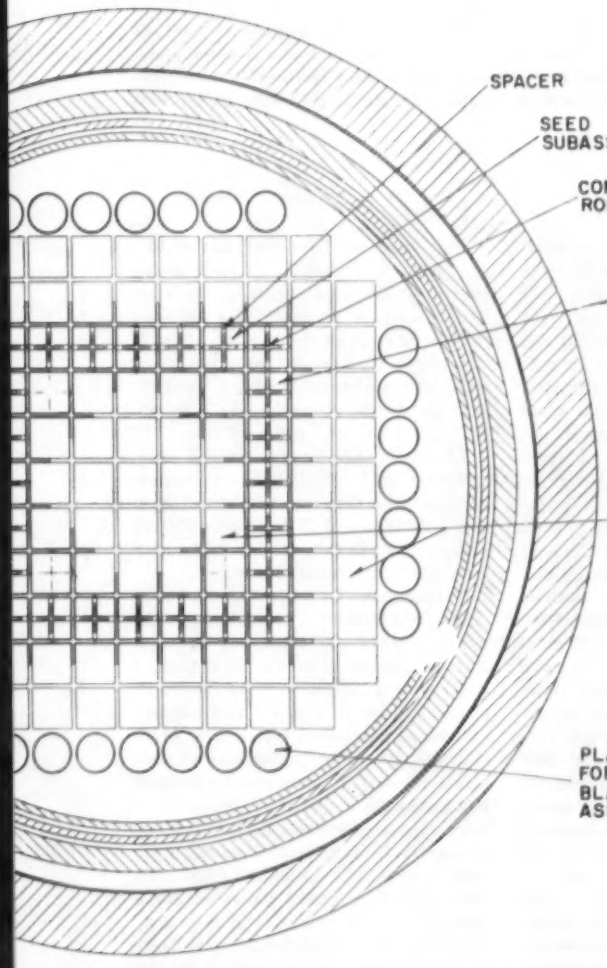
Vessel design. The reactor pressure vessel has a 9-ft ID and 8½-in. wall of carbon-steel plate and forgings with ¼-in. stainless-steel cladding. The vessel stands 33 ft high with a 6-in. thick bottom and a 10-in. thick cover bolted on with 42 6-in. studs.

Control-rod drives and fuel ports for removing fuel assemblies pierce the top cover. Fuel assemblies can be removed individually. By lifting off the top cover the whole core can be removed from the vessel. The containment tank surrounding the vessel holds a 3-ft thickness of shielding water. Concrete housing for tank gives additional exterior shielding. The entire assembly stands partly below ground level.

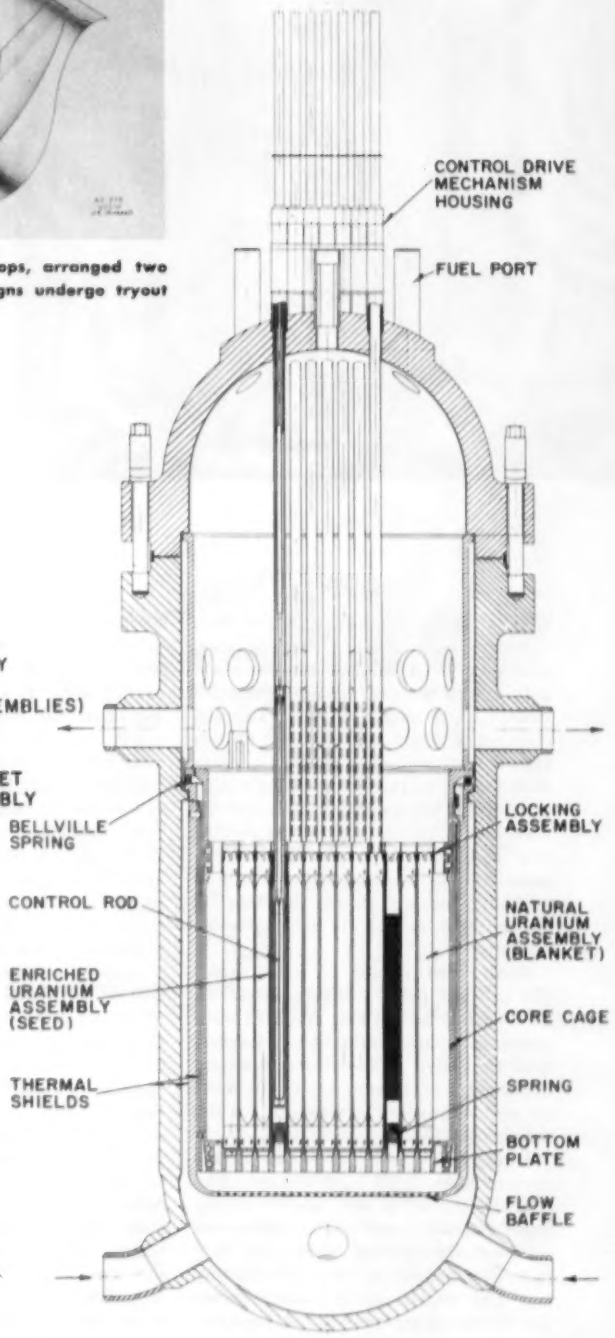
Coolant system. Maximum heat transfer out of the seed assemblies of the Shippingport reactor runs 382,000 Btu per hr per sq ft with an average of 112,000 Btu. In the blanket assemblies the maximum heat runs about 240,000



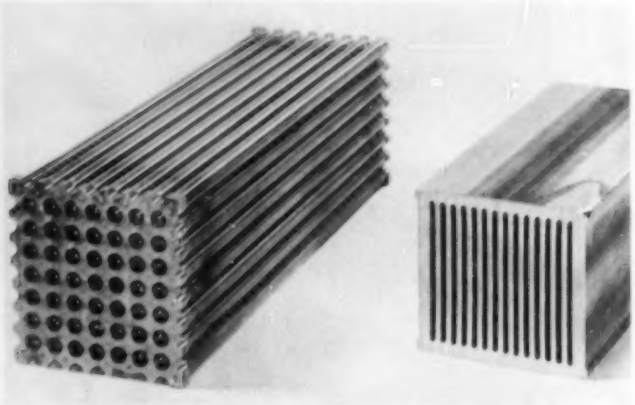
SHIPPINGPORT REACTOR in center tank feeds four coolant loops, arranged two each in adjacent containment tanks. Two different boiler designs undergo tryout



REACTOR CORE has 24 U-235 seed assemblies with cross-shaped control rod inserts and 93 UO_2 blanket assemblies



REACTOR VESSEL holds core in bottom half with control rods projecting up through dome. Coolant flows up thru core



FUEL ELEMENTS for Shippingport reactor: *left*, uranium oxide pellets in zircaloy tubing held in endplates so coolant flows over length; *right*, zircaloy-clad U-235 element with 14 coolant channels

REACTOR CORE CAGE for Shippingport holds all fuel assemblies locked in top grid and bottom plate. Close array forms critical mass generating heat carried away by coolant flowing upward through channels

Btu, for an average rate of 65,000 Btu.

Lower right diagram, *facing page*, shows the heat balance for the plant with one of the four coolant loops detailed. Each loop has four valves, a circulating pump and a boiler, all designed for 2000-psig operating pressure. Only 3 of the 4 loops need run to develop the 60-mw rated plant output.

Isolation valves next to the reactor inlet and outlet for each loop make it possible to isolate that loop for repairs without shutting down the reactor. These eight valves are hydraulically operated.

Center picture, *top of p 85*, shows one of these parallel-disk gate valves, hermetically sealed and operated by a piston in an integral cylinder. Latches hold the valve in the closed position. Eight manual valves next to the boilers and pumps act as backups for the automatically operated valves.

Pumps handling the radioactive coolant must have zero leakage. The "canned-motor" pump, *top left*, facing page, meets this need. Both stator and rotor of the driving motor are hermetically sealed in "cans" or sheathing. The water moved by the pump also serves as the bearing lubricant for both motor and pump. Bearings must have a large enough surface to compensate for poorer lubricating qualities of the water circulated in the system.

Water completely fills the air gap in the motor and any other spaces. The sealing sheaths add to the motor air-gap loss. Cooling coils surround the exterior of the stator winding to prevent their overheating. The electrical insulation must be resistant to nuclear radiations given off by the water.

A 1200-kw 2-speed 2300-v 3-phase motor drives the single-stage 15,000-gpm centrifugal pump made of stainless steel. The motor, weighing 20,000 lb, mounts in the cast stainless-steel volute with a seal-welded joint.

Steam generators of two designs will be used with the Shippingport reactor, *top p 83, and bottom left, p 85*. Both have a heat exchanger section and a steam drum. The h-p coolant flows through several hundred small stainless-steel tubes in the exchanger sections. Here the coolant gives up heat (524 to 508 F) to form steam bubbles in the boiler water surrounding the tubes. Mixture of boiler water and steam bubbles passes through the several risers to the drum above. Separators release the steam from the water to let the steam, at 600 psig and almost dry, leave the drum on its way to the turbine. The boiler water returns to the exchanger below through the downcomers shown on p 85.

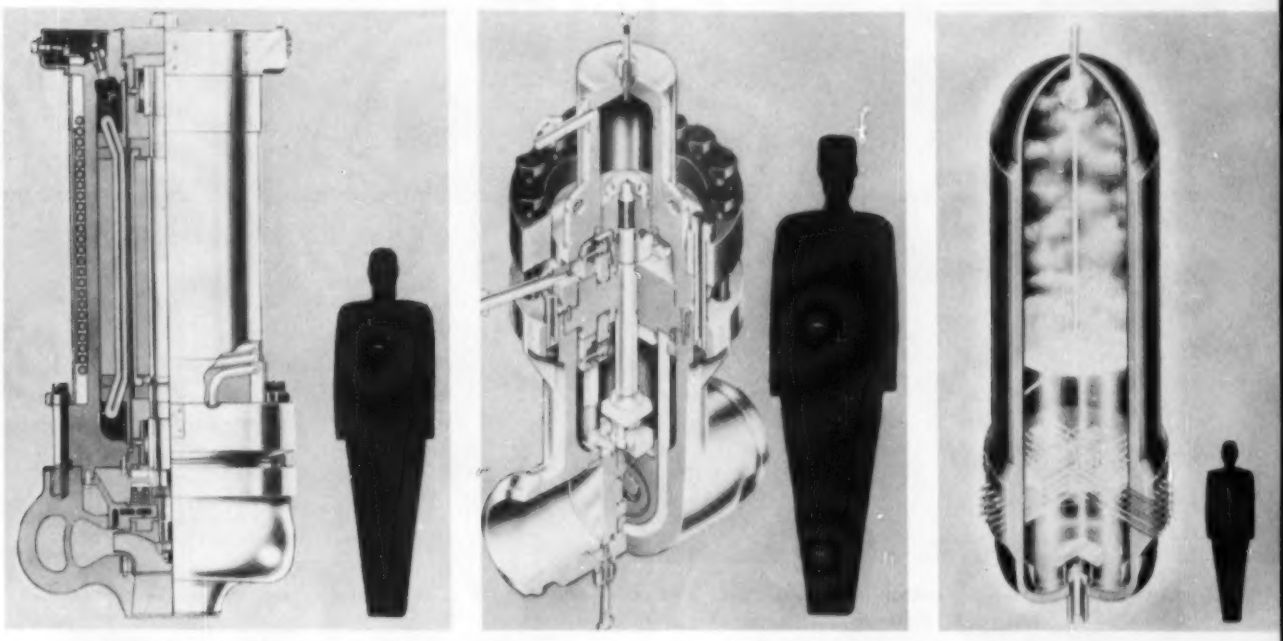
Boilers are each rated at 263×10^6 Btu per hr. The 600-psia full-load steam pressure rises to 885 psia at no load. The 2000-psia coolant flows through the exchangers at the rate of 6.5 million lb per hr. Two of the units are entirely of stainless steel with a straight-tube fixed-tube-sheet design. They are 36 ft long and 43 in. diameter.

The other two boilers, *facing page*, have return-bend U-tube exchanger sections with an overall length of 28 ft and a diameter of 39 in. Two different designs were chosen to give experience with different arrangements.

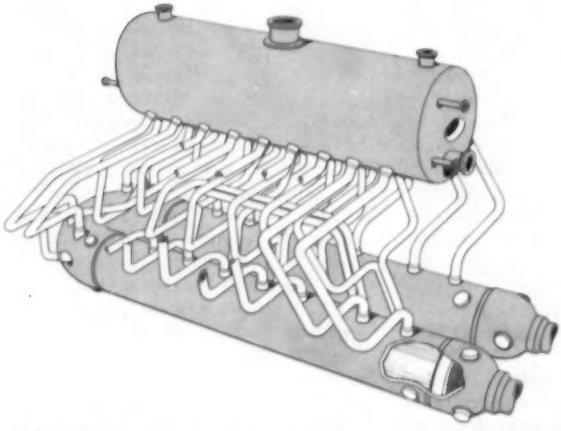
Pressurizer. To control coolant loop pressure a head or pressurizing tank must be used, *top right, facing page*. This Shippingport unit is 18 ft high, 5 ft ID with a total volume of 300 cu ft. About 150 cu ft acts as steam-dome volume at maximum water level. Normal surges will be as high as plus or minus 10 cu ft, corresponding to 1850 and 2185 psia as pressure limits.

The lower pressure must not fall below a level fixed by the reactor hot-spot temperature and the upper limit should not rise above the relief-valve setting.

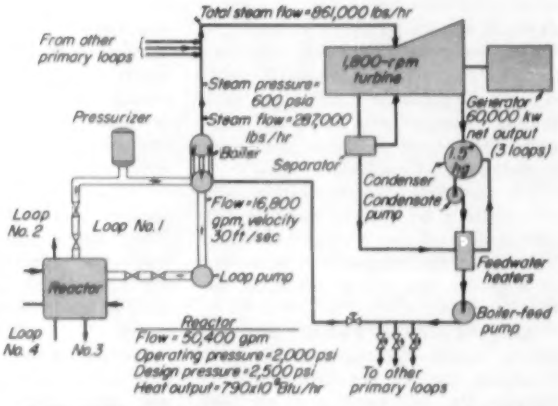
The 500-kw electric immersion heaters in the pressurizing tank supply the energy for initially raising coolant system pressure. The system and pres-



COOLANT-LOOP AUXILIARIES of Shippingport reactor must handle 2000-psig radioactive water: *left*, canned-motor pump prevents leakage completely; *center*, hydraulically-operated valve uses h-p water; *right*, electrically-heated pressurizer



STEAM GENERATOR has U-shaped heat exchanger to simplify expansion problem, and steam drum for steam-water separation



SHIPPINGPORT CYCLE has one reactor, four coolant loops feeding steam to turbine; separator dries all the l-p steam

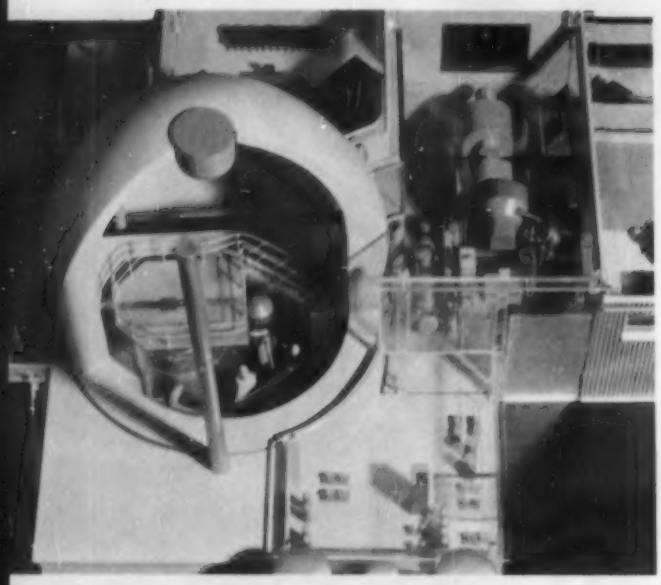
surizing tank must be filled with highly purified water to the proper level. Closing the system and starting the heaters warms the water in the tank till it boils. Boiling at constant volume gradually raises the steam and water pressure to the operating level of 2000 psig. During this heating operation the reactor would also be started and the coolant circulated and heated.

Water treatment. Two parallel treatment loops can be connected with the four coolant loops. Part of the coolant passes through the demineralizers in the treatment loops to be cleaned of soluble and insoluble impurities.

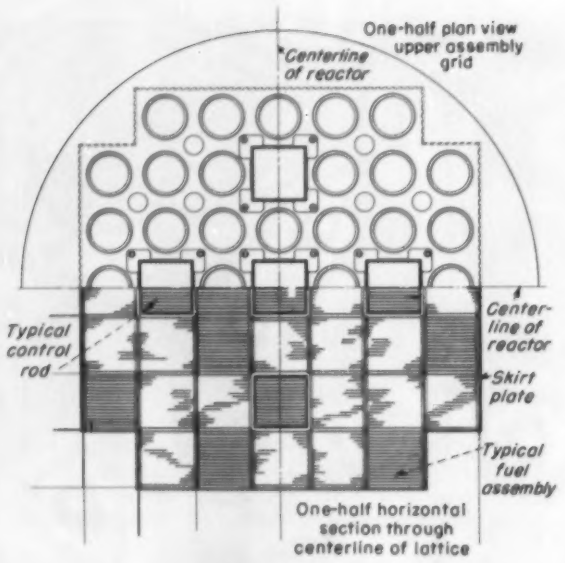
Steam turbine of the Shippingport Plant has a 100-mw rating and will run at 1800 rpm. Part way through the turbine where moisture builds up to 11.6%, all of the steam leaves the turbine to enter a separator. Here all but 1% of the moisture drains off and the steam returns to expand through the rest of the turbine. It exhausts to main condenser with 13.2% moisture.

Stainless steel lines the cylinder barrel between blade rows. All blades will be Stellite faced where steam moisture exceeds 6% and the blade tip speed is over 900 fps.

Gross turbine heat rate at 100,000 kw will be 11,385 Btu per kwhr; at 60,000 kw it will be about 13,200 Btu per kwhr—about 26% thermal effi-



ARMY PACKAGE POWER REACTOR has reactor, boiler, all of coolant loop enclosed in steel-concrete containment shell



APPR REACTOR CORE contains 40 fuel elements and 5 control rods. Fuel elements consist of plates, coolant channels

ciency at 60% of station capability.

The station can be started from cold in 3½ hr. Following an overnight shutdown it should be under load within 1¼ hr—somewhat faster than a conventional steam plant. A weekend shutdown will allow minor repair work within the shielding of the coolant system components without dangerous exposure to radioactivity.

The operating crew for Shippingport will initially be 130; of these 49 will not be needed for normal operation. This leaves 81, compared to 66 needed in a recent new steam plant on the same system.

Army Package Power Reactor, *above,* under construction by Alco Products, Inc, for the Army at Fort Belvoir, Va., will produce about 2000 kw electrically from a 10-mw heat-rated reactor. Reactor and all coolant-system components stand inside an upright containment tank. This steel cylinder is 28 ft high, 36 ft in dia with a ¼-in. thick wall and ½-in. thick hemispherical ends. An interior lining of 2-ft thick concrete guards against exploding parts puncturing the shell. Air inside containment tank will be force-cooled with river water.

APPR reactor has a cross section 20-in. square with the corners omitted, *top right diagram.* The 40 fuel elements and 5 control rods are 2-¼-in. square. The fuel elements held by top and bottom grids are supported in the lower part of the reactor tank, *top left, facing page.* This tank stands 8 ft high and has a 4-ft dia. Coolant enters tank bottom to flow up through reactor core and leave at the top nozzle.

Primary shield of iron and water in layers 47 in. thick completely surrounds the reactor vessel. This reduces external radiation to that from the coolant system inside the containment shell. Using iron stems from possibility of being unable to get aggregate for concrete shielding in remote locations. The concrete lining of the shell plus another three feet of concrete surrounding the shell reduces external radiation level to about 20% of allowable maximum.

Cooling water circulates through pipe inside the tank to remove radiation and conduction heat from the shield. Heat in the cast-iron ring and top shielding disks transfers by conduction to the shield tank and by convection to the air. Embedded cooling coils remove heat from the concrete below the reactor vessel.

APPR control-rod drive from the bottom of the core eliminates disconnecting rods when removing the reactor cover. The control rods consist of equal lengths of fuel and absorber portions, each as long as the core. The rods are each moved by a rack and pinion below, controlled through extension shafts. Disk-type shaft seals insure only sealing water leaking out and not radioactive coolant.

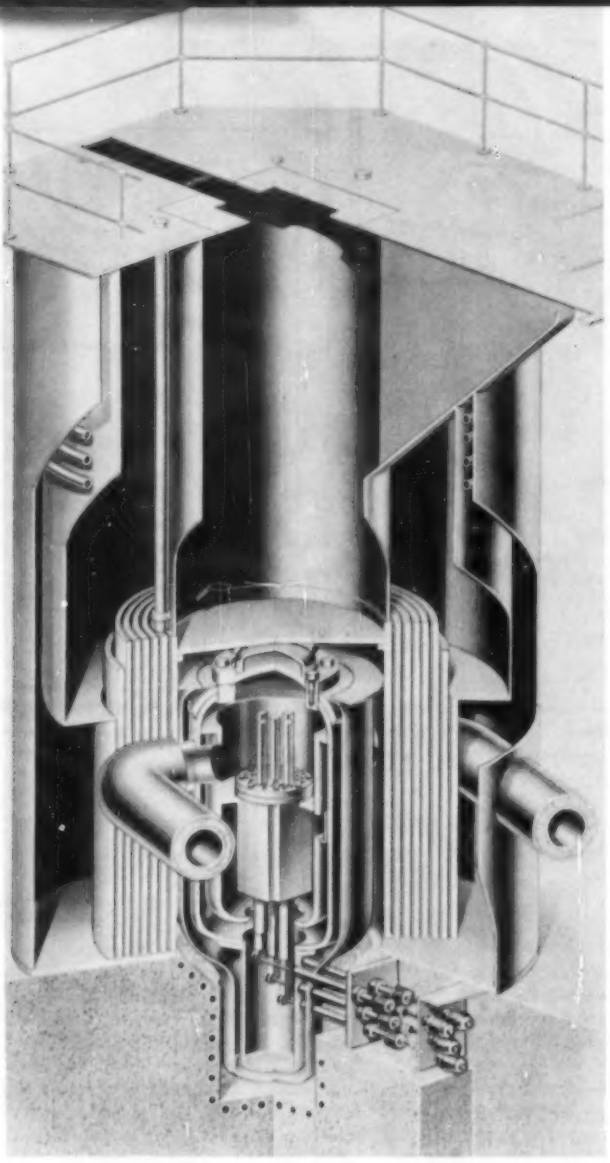
APPR coolant system has two circulating pumps passing 4000 gpm of 1200-psia water in a closed loop between reactor vessel and steam generator. Water enters reactor at 431 F at full load and leaves at 450 F.

Each pump can handle the full-load flow. Both units are "canned-motor" type to eliminate all leakage. A swing check valve allows a small backflow to the idle pump to prevent its cooling more than 10 F below the operating pump. A pressurizing vessel with two 50-kw heaters maintains a pressure of 1200 psia in the coolant system.

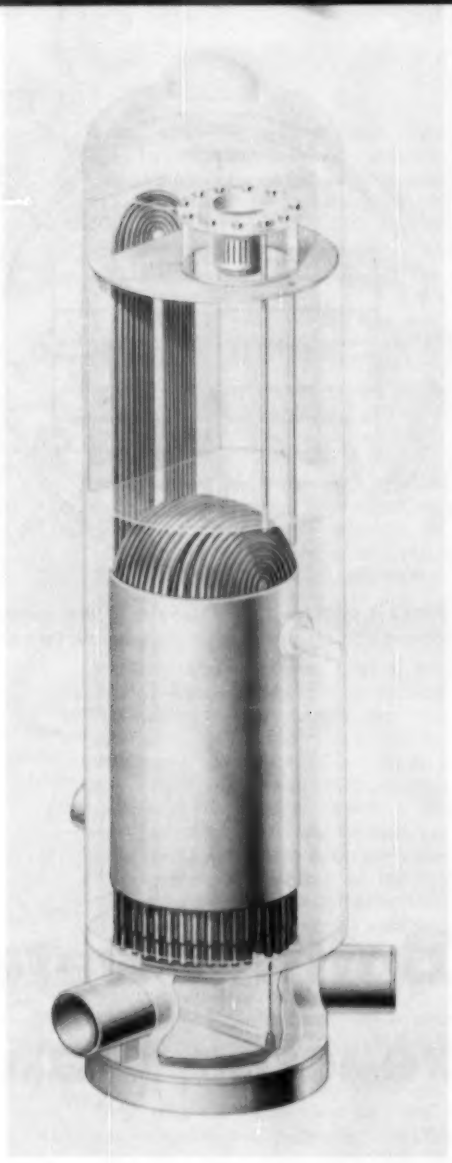
APPR steam system has a steam generator heated by the coolant to produce 200-psia steam with 25-F superheat, at full load. At no load the pressure rises to about 425 psia.

The steam generator, *upper right, facing page,* has vertical U-tubes for the coolant. The boiler water is held by the shell to immerse the majority of the tubes. Feedwater enters the center side of the shell. Boiler water circulates upward between tubes to form and carry steam bubbles, releasing them at water level. The water flows downward through the annular space surrounding tubes. Steam flows upward through the separator and then down through the superheating pass over the extended U-tubes to leave near the bottom of the shell on its way to the turbine.

The 2500-kw turbine will be designed for 250-psig inlet pressure. A pressure-reducing valve ahead of the turbine



APPR REACTOR SHIELDING uses iron and water to reduce gamma-ray level about equal to that from coolant circuit



BOILER OF APPR uses single shell, U-tubes. Outlet pass moderately superheats steam to turbine

will hold steam pressure to the design level as load decreases.

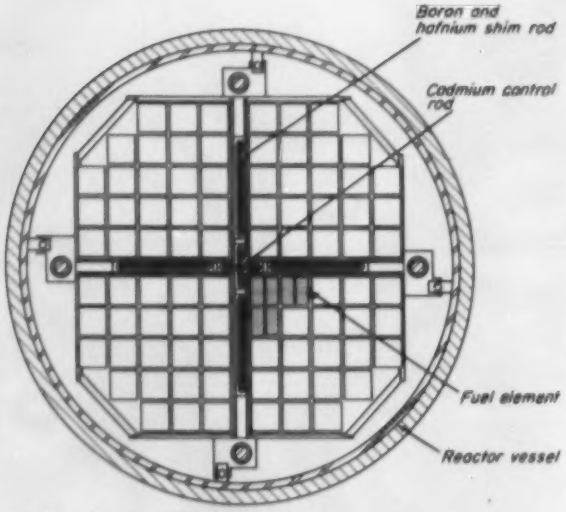
Water-treatment system starts with a 5,000-gal storage tank. From this tank makeup enters the steam system through an evaporator that reduces impurities to less than 1 ppm. The vapor passes to the feedwater heater and the condensate flashes to the condenser. Evaporator and steam generator blowdown runs at about 300 lb per hr.

Makeup for the coolant system comes from the main condenser hotwell. It passes through a demineralizer, heat exchanger and degasifier. The initial impurity content drops from a possible high of 5 ppm in the hotwell to less than ½ ppm in the coolant storage tank. The makeup replaces coolant-system blowdown needed to remove possible erosion and corrosion products.

Consolidated Edison PWR plant at Indian Point, N. Y., will be the internal thorium converter type fueled with highly enriched U-235. Plant will be rated at 236,000 kw electrically. Reactor will produce 1,900,000 lb per hr of saturated steam at 420 psia that will be superheated to 1000 F at 370 psia in an oil-fired superheater. Gross plant thermal efficiency of this station is expected to be about 34%.

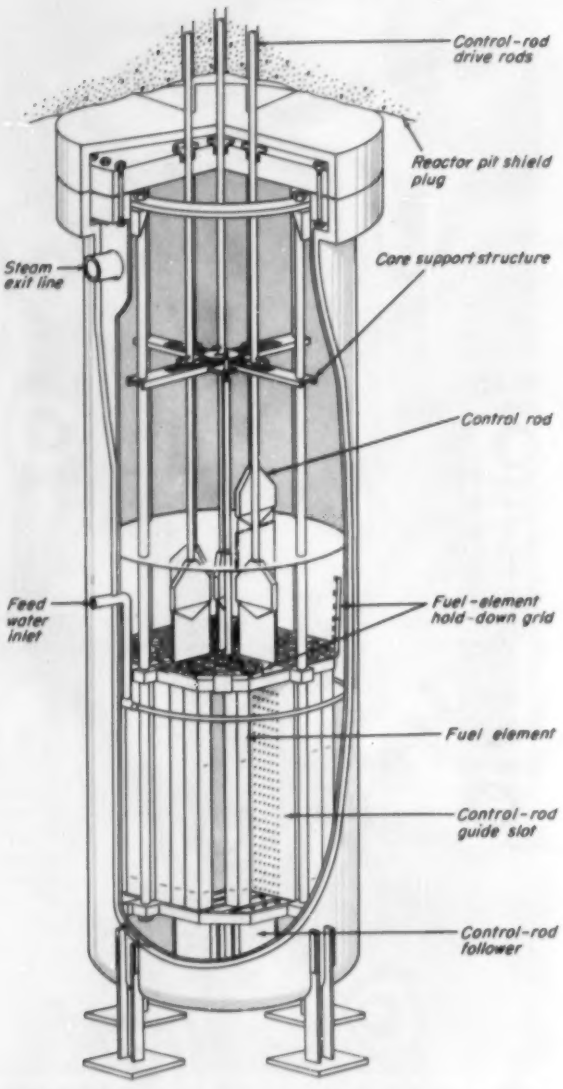
Active part of reactor core occupies cylinder 6 ft x 6 ft. Coolant flows through channels between plates of the square fuel assemblies. U-235 will be alloyed with Zircaloy. Both fuel and thorium elements will be clad with Zircaloy. Reactor core will contain 8100 kg of thorium and about 210 kg of U-235. Coolant system circulates 120,000 gpm at 1500 psia. Water enters reactor at 480 F, leaves at 510 F. Reactor supplies four boiler loops, each having two 15,000-gpm pumps in parallel, check valves and remotely operated stop valve.

No details are available on Yankee Atomic Electric Co's 100,000-kw PWR.



BORAX-3 CORE has 87 fuel elements of 90% enriched uranium, alloyed with aluminum and aluminum-clad. Core holds 11.8 kg

Boiling-water reactor plants



CUTAWAY VIEW shows core construction, supports, water and steam connections. Note large steam space above water line

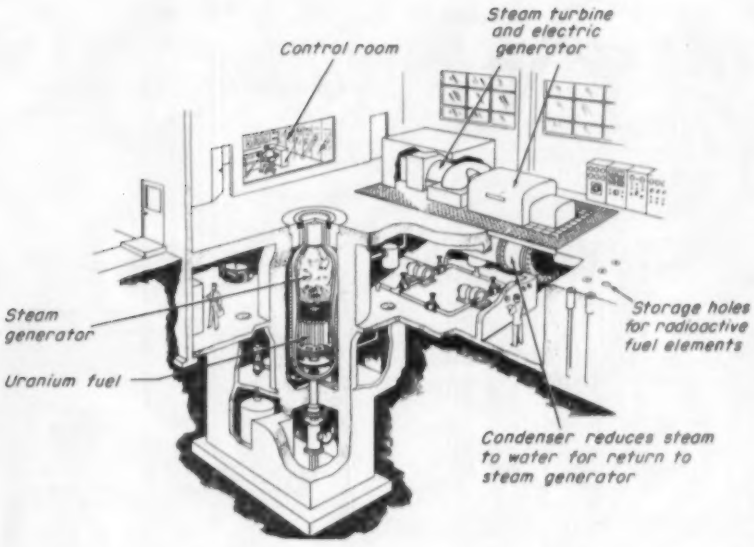
Like the PWR's just covered, the boiling-water reactor also uses light water as coolant and moderator, with solid fuel elements. It differs from the pressurized-water reactor, however, in that steam is generated in the reactor vessel and goes directly to the turbine generator. There is thus only a single loop, no heat exchangers, and reactor pressure is essentially the same as steam pressure. This permits a higher thermal efficiency for a given reactor coolant temperature than with a PWR.

An immediate question about this design concerns the steam—isn't it dangerously radioactive? It is radioactive and, in normal operation, steam lines, turbine, condenser, pumps, condensate piping, etc, require shielding. This may be on individual pieces of equipment, or the entire plant may be enclosed in a shielded area and operated remotely.

In operation, the activation of oxygen in the water far exceeds the contribution of any corrosion products that might be present. Since the oxygen content is known accurately, radioactivity levels during operation may be predicted closely. Activity of the turbine during maintenance is, however, independent of steam and water activity, which is short lived. Here deposited corrosion products are the prime consideration and the question is how many radioactive elements, and what kind, will deposit in the system.

Impurities may enter the water by corrosion of material in the nuclear field, or minerals in the water entering the system may be irradiated in passing through the reactor. Demineralizing equipment will remove most such impurities and separation in the steam drum helps further. Under normal conditions, deposits are not expected to build up sufficiently to seriously hamper maintenance work.

Should deposits prove a problem, the system may be flushed. Tests indicate this might reduce activity by a factor between 10 and 100. If a fuel element should fail, and some turbine work was required soon afterward, it might be necessary to flush out the turbine.


Steam turbine and electric generator
Control room
Steam generator
Uranium fuel
Storage holes for radioactive fuel elements
Condenser reduces steam to water for return to steam generator

ARGONNE BOILING-WATER REACTOR, scheduled for 1956 operation at Lemont, Ill., is rated 5000 kw. Diagram shows general layout of related generating equipment

Safety and stability. A less obvious question, but a more vital one, concerns the nuclear effects of a moderator partly in the vapor phase. In fact, before 1953 such a direct-boiling reactor was feared to be dangerously unstable. As a result of theoretical studies and lab tests at Argonne National Laboratory, it was concluded that a properly designed boiling-water reactor would actually prove to be exceptionally stable. Later experience with experimental reactors indicates that formation of steam bubbles in the moderating water reduces reactivity by allowing neutron leakage to increase.

Stability tests. In the now-famous Borax I experiments, the stability of this reactor type was tested under extreme conditions. After about two years of experimental operation, the Borax I boiling reactor at Arco, Idaho was arranged so a control rod could be ejected rapidly from the core, producing an excessively fast power increase. This simulated what might happen in an operating reactor if the rods should lose control.

Under these conditions, sudden increase in power level caused heavy steam formation around the main fuel elements and the resulting absence of moderating water immediately reduced reactor power level. Even with power increases up to ten times in about 1/100th second, maximum temperature didn't approach fuel melting temperature. The only mechanical change resulted from rapid pressure rise in the reactor core.

In a final test to destruction, fuel plates were melted, reactor tank burst, while most of superstructure was scattered. Although reactor was deliberately destroyed, the explosion was relatively mild, equivalent to a few pounds of TNT. There was no appreciable radioactive fallout at distances greater than a few hundred feet. It was possible to salvage some of the equipment.

Borax-3 reactor. Of the successors to deliberately destroyed Borax I, Borax 3 was designed for operating experience with this type. General arrangement is shown at top of facing page. Fuel is 90% enriched uranium, alloyed with aluminum and aluminum-clad. It is interesting to note that core contains 87 elements, each of which cost $425 to fabricate. Fully loaded, core contains 11.8 kg: this covers critical mass, operating losses and allows 2 kg for burnup.

Water flows up through fuel elements and steam formed separates in large space above. Cooler water flows down near vessel walls, acting as reflector. One cross-shape and four blade-type control rods act vertically. Cadmium, boron and hafnium are used as absorbers. For continuous operation, where burnup steadily reduces available reactivity, burnup plates incorporating boron are affixed to the fuel elements.

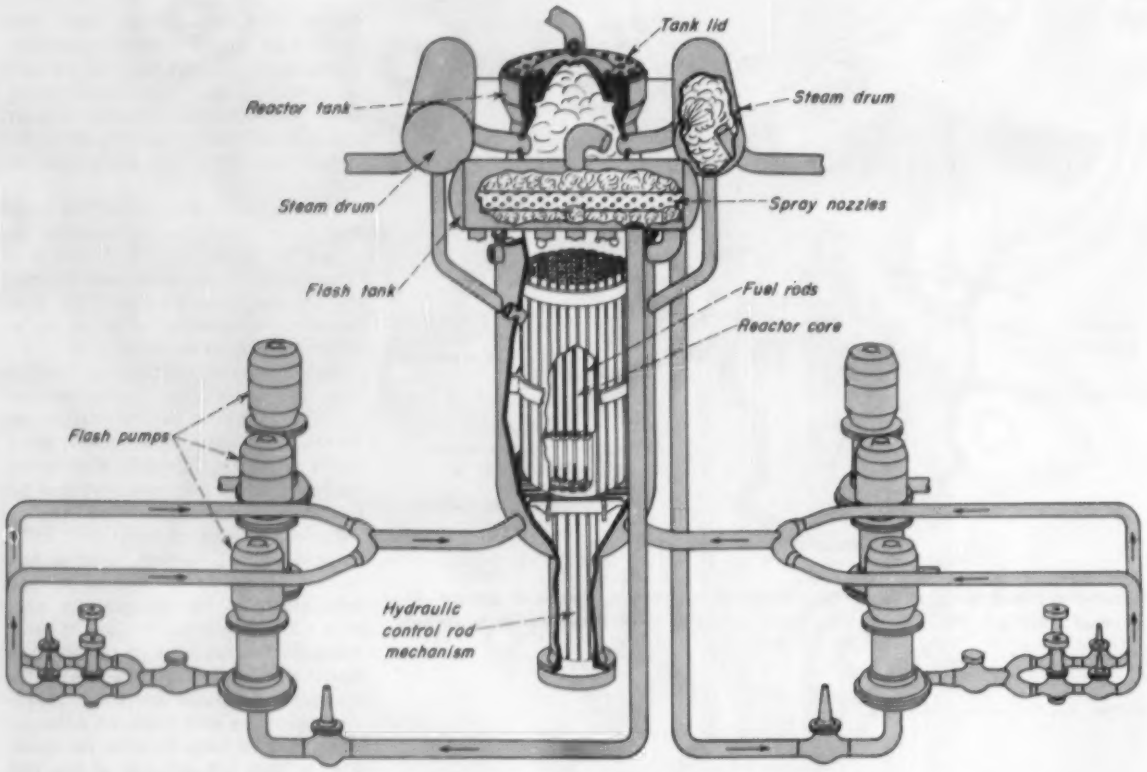
This boiling-water reactor has operated under stable conditions from atmospheric to 300 psi. At 12-mw heat output and 300 psi, short-period power fluctuations amounting to 3.2% produced no detectable variations in reactor pressure or in steam flow.

Based on a cost of $550,000, of which over 50% is in power conversion and cooling equipment, capital charges run 5.9 mills per kwhr, figuring 80% plant factor, 2000-kw capacity. Estimating 1.8 fuel charges per year, and that 1.5 loadings will always be committed to the plant, inventory costs 0.76 mills per kwhr at 4% interest. Cost of fuel burned up comes to 3.85 mills, and fabrication of 1.8 charges per year adds 4.7 mills per kwhr. Cost of processing fuel is taken at $5 per gram, a figure now considered practical. This represents 6.2 mills per kwhr. A 12-man operating staff costs 8.6 mills per kwhr, making total 30 mills per kwhr. This is high but not out of the ball park for a 2000-kw plant, particularly if it were in a high-fuel-cost area.

5000-kw unit. In the 5-yr reactor development program, the boiling-water design will be represented by a 5000-kw unit under construction near Lemont, Ill, scheduled for operation in 1956. Design of the reactor is responsibility of Argonne National Laboratory, with Allis Chalmers Mfg Co a major contractor, supplying virtually all generating equipment outside the reactor. The sketch to the left gives a general idea of the plant layout.

Two commercial-scale proposals embody modifications of the direct-boiling cycle. Largest of these is the 180,000-kw installation to be erected about 50 miles southwest of Chicago by the Nuclear Power Group, headed by Commonwealth Edison Co. This plant was originally proposed as one of the power-demonstration reactors but was later withdrawn and resubmitted as a license application in the name of Commonwealth Edison, without use of government funds or guarantees.

Dual-cycle design. To be designed and built by General Electric Co, this plant will use what is called the dual-cycle boiling reactor. Proponents of the dual cycle argue that the direct-boiling design has limitations in response to load demand and in power output per unit volume. Both could be handicaps for application in central stations.



DUAL-CYCLE BOILING REACTOR supplies 600-psi steam direct to turbine. Part of water goes to flash tanks and produces 350-psi steam that is admitted at later stage of turbine. Energy from flash cycle about equals that from direct boiling

Dual- and closed-cycle boiling designs

In the dual-cycle unit, diagrammed above, boiling is limited to a short upper section. At the core exit, percent of steam by weight may be of the order of 3%. The 600-psi steam formed in the reactor goes to steam-separator drums for moisture removal and then directly to the first turbine stage.

Part of the water, about 37%, flows through orifices in a pair of flash tanks where about 8% flashes to steam at 350 psi. This steam enters the mixed-pressure turbine at a later stage. Energy from flash cycle runs about equal to that taken from boiling cycle.

The 432-F water that doesn't flash mixes with returning condensate, which has been preheated and pumped back to the reactor. Here it mixes with the remaining 60% at 486 F, which returns by natural circulation in a downcomer on the inside of the reactor vessel.

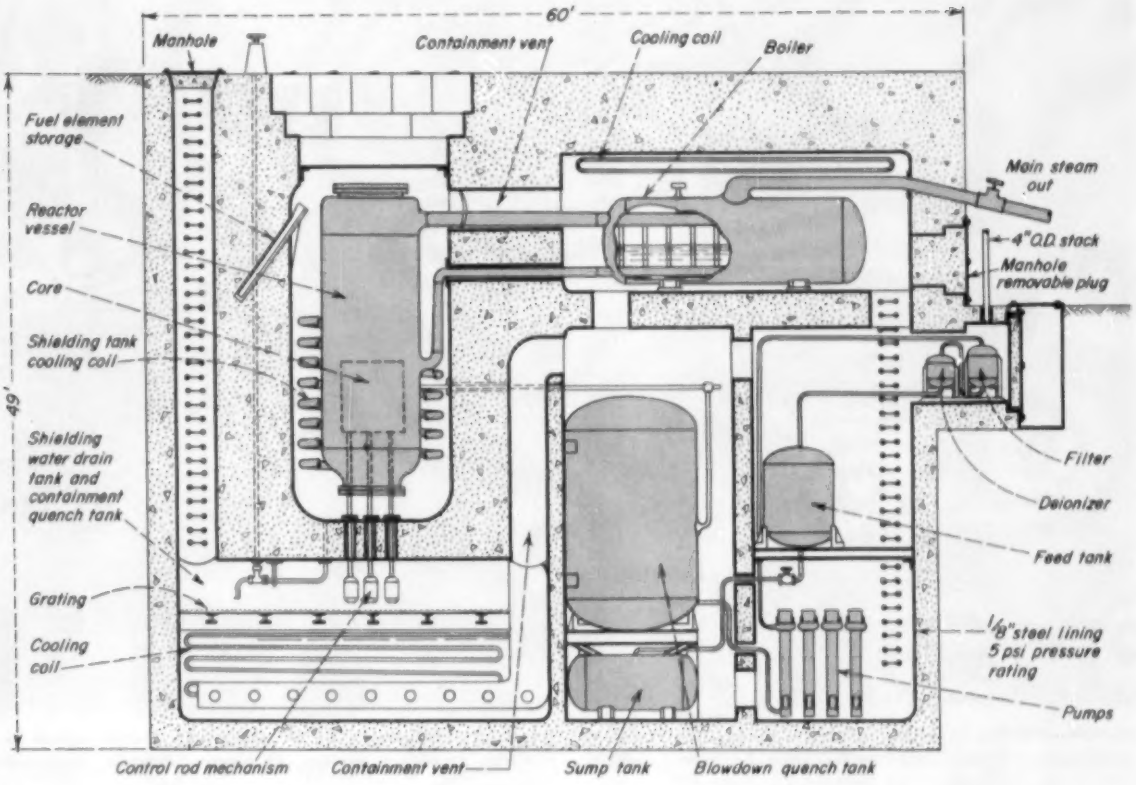
Performance. For the same reactor fluid temperature, thermal performance of the dual cycle is about midway between a pressurized-water reactor and a direct-boiling reactor. At partial loads, dual-cycle thermal performance improves relatively because more power comes from direct boiling than from flash.

With this cycle a high degree of self regulation is obtained. When load increases, the 350-psi throttle opens, reducing pressure in the flash tanks. The 3-point control valve then allows more flow from the circulating pumps. This results in more subcooling in the reactor and a decrease in boiling length. There are then fewer voids and reactivity increases, raising power level. When load falls off, a generally reverse situation maintains, voids increase, reactivity decreases and reactor power level is lowered.

Reactor core. As presently described, the reactor core consists of a vertical array of slightly enriched uranium rods. They are supported in hexagonal zirconium coolant channels in a honeycomb pattern. Coolant channels extend above the reactor core to form chimneys which promote natural circulation of the steam-water mixture. Upper part of tank serves as a steam dome to dampen pressure variations so rapid power fluctuations don't materially affect reactor voids.

The vertical control rods are actuated by hydraulic pistons; this mechanism is at bottom of reactor. This frees the head of the vessel, which has a large lid for access when fuel elements are replaced or repairs are made. The closure is designed so internal pressure acts to seat the lid.

Closed-cycle design. Aiming at the requirements of smaller utility and municipal plants (10 to 20 mw of electricity) AMF Atomics Inc (division of American Machine & Foundry Co) has developed another modification—the closed-cycle boiling-water reactor. As described in detail in POWER (Sept 1955, pp 75-81) and pictured on facing page, the plant consists of a boiling heterogeneous reactor with a separate primary heat exchanger and the usual generating equipment and auxiliaries. The reactor uses natural-uranium fuel elements clad with a zirconium alloy.



CLOSED-CYCLE BOILING REACTOR supplies 1200-psi steam to tubes of exchanger that generates 600-psi steam. Varying water level in drum holds secondary-system steam pressure constant. No pumps, valves in natural-circulation primary loop

Enriched-uranium elements, similarly clad, "spike" the core (increase its reactivity).

Water in the reactor boils at 567 F, with maximum fuel-element surface temperature being held to about 580 F. Steam from the reactor, at 1200 psig, flows to the tube-side heat-transfer surface in the primary heat exchanger. There it condenses and returns by gravity to the reactor vessel. Natural convection produces circulation within the reactor vessel, and the primary circuit has neither pumps nor valves.

Heat exchanger is a drum (650 psig) containing a large number of short, vertical tubes. Varying water level in the drum maintains constant steam pressure in the secondary system. This varies effective heat-transfer surface so plant-load variations can be accommodated without affecting pressures and temperatures in primary and secondary steam loops. The heat capacity of the primary exchanger adds flywheel effect to the system and thus relaxes requirements on the control equipment.

The 20,000-kw plant illustrated above is enclosed in a concrete block about 16 ft wide, 60 ft long, and 50 ft deep, largely underground. On top of this block a simple structure, for weather protection only, has a monorail that extends out at one end to handle fuel casks.

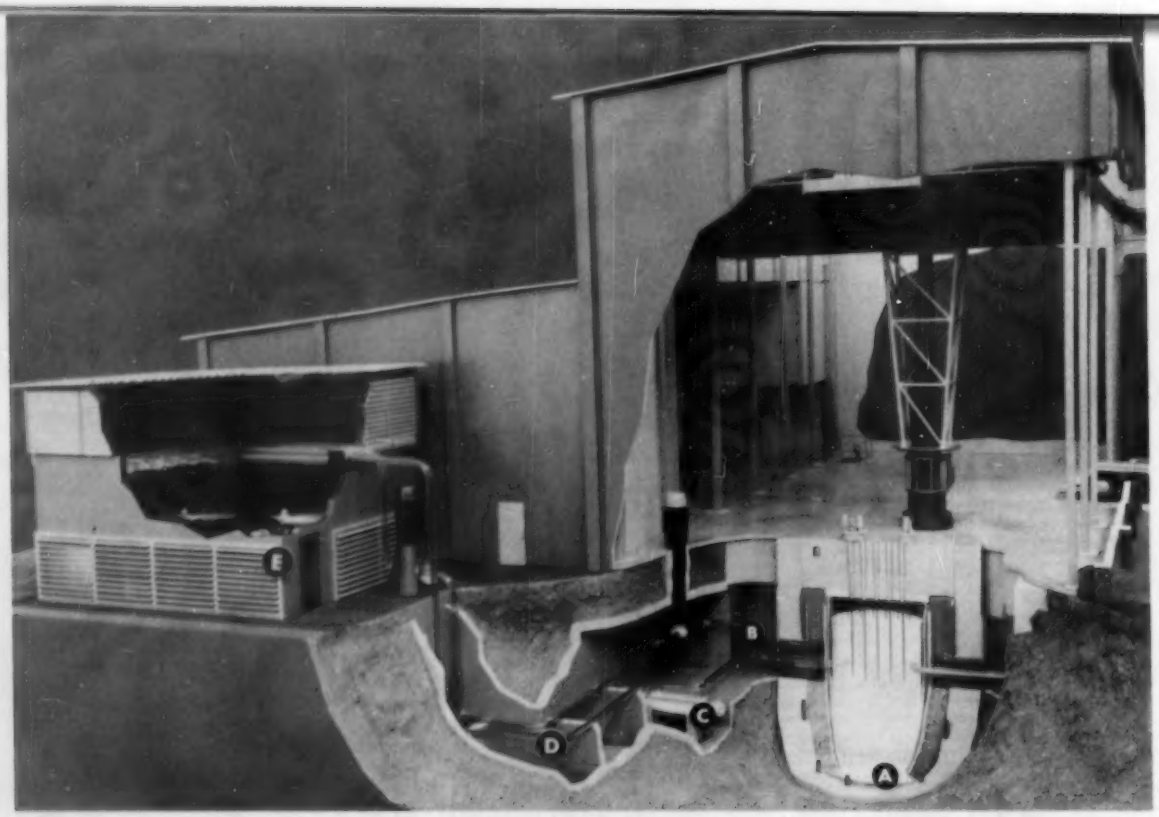
Auxiliaries within the containment structure can be serviced during reactor operation—entering by way of an air lock with hose ventilation if desired. All pumps and valves will be a maximum distance from reactor for ease in servicing. After startup, however, this area will be entered only rarely. Enough remotely operated spares will be provided so servicing will normally be done only during reactor shutdown.

Purification. Circulating pump, filter and demineralizer remove suspended and dissolved impurities from the primary water. This system takes its suction from the blowdown quench tank and discharges to the feed tank. Constant circulation through the demineralizer gives continuous purification. When operating this way, reactor vessel is blown down periodically with a corresponding amount of makeup coming from the feed tanks.

The feed tank inside the containment shell stores feedwater for the entire shell. A pump transfers feed water from the tank to the system. A 50,000-gal storage tank above ground will supply demineralized water to the shield tank. Fuel-loading operations require this large quantity of water.

Control system. As mentioned earlier, varying water level in heat exchanger controls secondary steam pressure. An element sensing this pressure signals a boiler-level regulator adjusting rate of feedwater flow to the boiler drum. Steam-flow measurement serves as an anticipatory signal in the control system, improving response.

Reactor steam pressure is controlled independently of the secondary loop. Control rods move in response to a signal representing reactor pressure. As in the secondary loop, steam flow provides an anticipatory signal. Decrease in reactor pressure causes control rods to be moved out of the core; a pressure increase causes them to be reinserted, to reduce reactivity.



SODIUM-GRAPHITE REACTOR, pictured in scale-model form, has stainless-steel-jacketed uranium fuel slugs, hexagonal graphite prisms in zirconium cans for moderator. Liquid sodium is primary, secondary coolant. At present, heat is dissipated

Sodium-graphite reactors and

Now we come to a reactor type using graphite as moderator and liquid sodium as coolant. The liquid-metal system permits high temperatures without high pressures. It thus offers the possibility of steam-cycle efficiencies like those of modern conventional plants.

Liquid-metal coolants. Fluid dynamics of sodium resemble those of water but it has much higher heat capacity and conductivity. Sodium systems present no special corrosion problems and choice of materials is wide. But extreme care must be taken to keep sodium from contacting water or oxygen, with both of which it reacts violently.

After exposure to reactor neutrons, sodium becomes highly radioactive, with a half life of about 15 hr. For information on pumps, valves, heat exchangers for liquid metals, see *Nuclear Energy Study Course*, No. 14, Oct 1955, pp 108-110.

Sodium-graphite reactor. Scale model above shows a 20-mw (heat) unit being built by North American Aviation, Inc, as part of AEC's 5-yr reactor development program. It is designed for flexibility in testing fuel elements, layouts, operating methods. The 7-ft-dia core could turn out about four times as much heat if designed for that purpose only.

As shown above, heat produced in core *A* is absorbed by circulating liquid sodium *B*. This goes to heat exchanger *C* where a secondary sodium systems absorbs heat from first. Hot sodium in secondary system *D* goes to heat-dissipating coils and fans *E*. AEC has asked proposals for use of this heat—enough to generate about 7500 kw of electricity.

The sodium-graphite reactor can use slightly enriched uranium or thorium initially enriched with U-235. Present information makes thorium look attractive: fuel elements may be run at higher temperatures than uranium and liquid-metal coolant can take advantage of this.

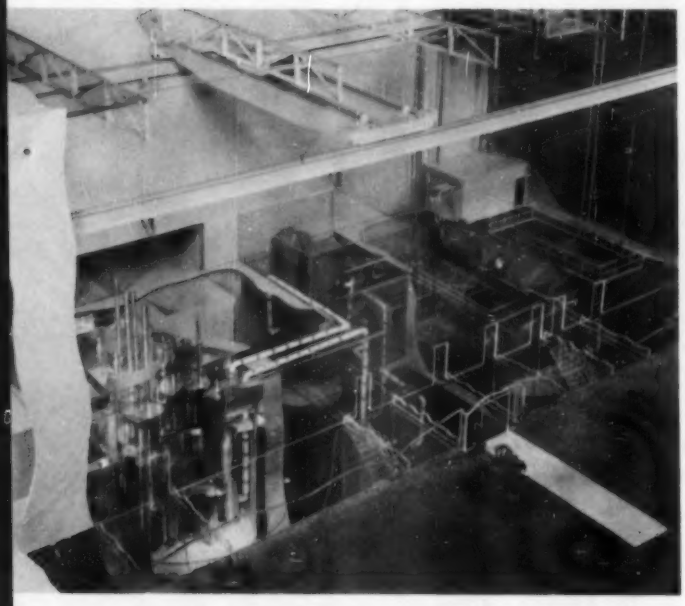
FAST BREEDER REACTORS

The number of *fast* reactors thus far built is small compared to *thermal* reactors using "slow" neutrons. First fast reactor, using plutonium as fuel, was an experimental unit at Los Alamos. The second was an experimental breeder reactor built by Argonne National Laboratory at Arco, Idaho.

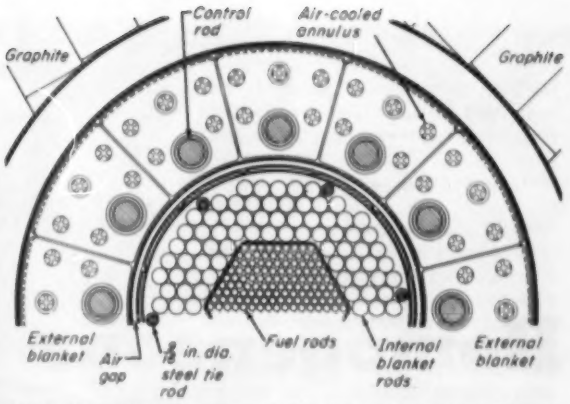
Fast breeder. Core of this EBR-1 unit gives an idea of construction of this type. Fuel slugs—U-235 in stainless-steel cans—form a tight vertical array in center. Each fuel rod has two U-235 slugs, with a U-238 slug top and bottom to form a blanket at ends of core. Upper space in each rod collects fission gases. Top shielding section of stainless serves as handle for removing rods.

Inner blanket, next to core, consists of U-238 rods in stainless tubes, with upper shielding and handling sections. Outer blanket section has keystone-shaped U-238 bricks in stainless jackets. Inner and outer aluminum shells hold blanket stacks. Around outer blanket and an air gap is another aluminum shell and an 18-in.-thick graphite reflector. Then comes an air-cooled 6-in. iron shield for thermal neutrons and 9 ft of concrete.

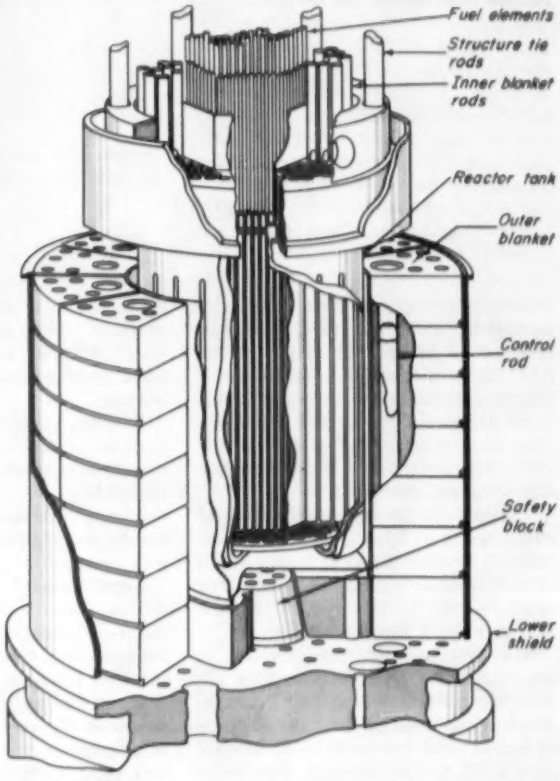
Core produces 72% of reactor heat output; blankets



FAST BREEDER EBR-2, shown here in model form, is rated at 15,000 kw. It's scheduled for 1958 operation at Arco, Idaho



EBR-1 CORE SECTION shows U-235 fuel rods, inner and outer blankets of U-238, control rods, air gaps, graphite reflector



EBR-1 CUTAWAY reveals core construction. Keystone-shaped blanket blocks have openings for control rods and air cooling

fast breeders

generate 14% each. The outer blanket is cooled by air.

Coolant system. Sodium-potassium-alloy coolant enters reactor tank above blanket section, flows through top plate in fluted section of rods and down between blanket rods to bottom. Then it flows up among fuel rods, through top fluted sections and out at about 600 F.

Primary coolant goes to a heat exchanger, gives up heat to secondary NaK at 419 F and returns to reactor. Secondary NaK, heated to 590 F, goes to a steam generator which supplies a 405-psia 529-F turbine-generator for plant service. This unit produced world's first nuclear power in Dec 1951.

EBR-2, 15,000-kw successor to EBR-1 just described, is part of 5-yr reactor program. Designed by Argonne and located at Arco, it is scheduled for 1958 operation. Unit will use enriched uranium and have liquid-metal coolant system.

The fast breeder is the choice of the Detroit Edison group in the power-demonstration program. They propose a 100,000-kw unit for 1959 operation.

Fast-breeder interest stems first from its potential for production of fuel materials. This is believed greater than that of any thermal reactor and, in some quarters at least, achievement of breeding is considered imperative if there is to be a large nuclear-energy industry.

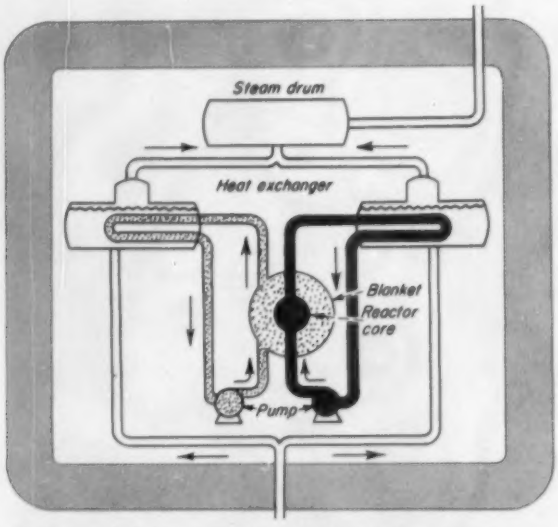
In addition to breeding potential, the fast breeder offers flexibility in respect to fuels and processes. It is not unreasonable to expect a fast reactor to burn either U-235, U-233, or plutonium, and to produce either U-233 from a thorium blanket or plutonium from a uranium blanket.

The fast reactor can realize the advantages of liquid-metal coolants in the direction of higher temperatures. And the fast reactor permits wide latitude in selection of materials—less-stringent neutron-economy requirements, for example, permit using steel for structure and cladding.

Disadvantages. Some regard the fast reactor as less inherently stable than thermal types. Theoretical studies indicate, however, that the fast reactor, in addition to being stable, may offer some advantage because it can be designed with a minimum of excess reactivity.

Fast reactors need a relatively large critical mass—thus a heavy fuel inventory. This may be less important in the future when nuclear fuels are more plentiful.

Homogeneous reactors



HOMOGENEOUS REACTOR with breeder blanket: simplified diagram of 100,000-kw unit shows heat exchangers and steam drum

The nuclear "dream cycle" was described by Dr L R Hafstad, former director of reactor development for AEC, as "a pot, a pump, and a pipe." The homogeneous reactor aims at this ideal of simplicity. As the name implies, fuel, coolant and moderator (if any) are combined in a solution, slurry, or metallic fluid.

The fuel-coolant-moderator mixture circulates in a closed system (diagram above). Reactor vessel is large enough so fuel reaches critical mass in it, but nowhere else in the system. Circuit also includes a heat exchanger.

In addition to the obvious virtue of simplicity, the homogeneous idea offers possibilities of long fuel burnups. There is reason to believe that presence of fission products is not as disturbing in a fluid fuel mixture as in a solid element. And with fluid fuel there is no concern over structural integrity.

Continuous operation. Another promise of the homogeneous concept is the possibility of separating fission products and reprocessing fuel continuously. The fact that fuel is already in solution should simplify chemical treatment.

In most homogeneous reactor experiments thus far, fuel has been uranyl sulfate. Both light and heavy water (D_2O) have been used as moderator and coolant. Heavy water, weakest liquid absorber of neutrons, is most desirable from nuclear standpoint. It has about same boiling and critical temperatures as light water but costs a lot more. Recently announced AEC figure is $28 per lb. Aqueous systems, using either light or heavy water, involve high pressures if reasonably high temperatures are to be obtained.

Primary problems of the homogeneous design arise in handling the circulating mixture. This is highly radioactive. A leak-tight system is needed—in the face of highly corrosive conditions. Uranyl sulfate is acid and gets more so at higher temperatures.

Experimental units. The second nuclear reactor actually to produce electrical energy was a homogeneous experimental unit (HRE-1). It was rated at 1000-kw of heat. In over two years of intermittent operation it demonstrated the essential stability of the homogeneous type, and possibility of leak-tight operation.

The 5-yr reactor program includes a successor to this first unit, with a heat output of 5 to 10 mw. Known as HRT, this unit is also located at Oak Ridge National Laboratory, starts in 1956.

Reactor vessel of HRT is pictured top of facing page. Fuel mixture (uranyl sulfate in heavy water) enters central bulb-shaped core at about 490 F and leaves at about 570 F. Pressurizer keeps fuel mix from boiling. Fuel leaving reactor goes to a gas separator where directional vanes separate off radiolytic and fission-product gases. These are bled off to a separate low-pressure system that recombines D_2 and O on a catalyst.

Fuel solution goes on to a heat exchanger where it is cooled to 490 F by giving up heat to feedwater. Part of the 470-F 520-psi steam produced goes to a 312-kva turbine-generator, the rest to an air-cooled steam condenser. A canned-rotor pump returns uranyl sulfate solution to the reactor vessel.

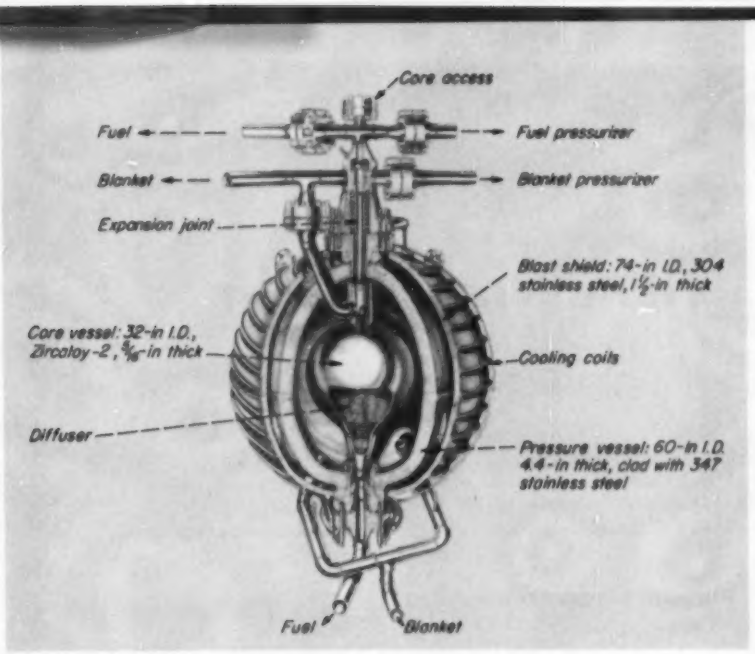
This unit is designed to explore breeding possibilities. Space between core and egg-shaped pressure vessel is intended for a breeder blanket, but will carry heavy water temporarily.

Control. This unit has no control or safety rods. The system is inherently stable. Temperature control is effected by regulating concentration of fuel in the core; power level is set by the rate of heat removal from the reactor.

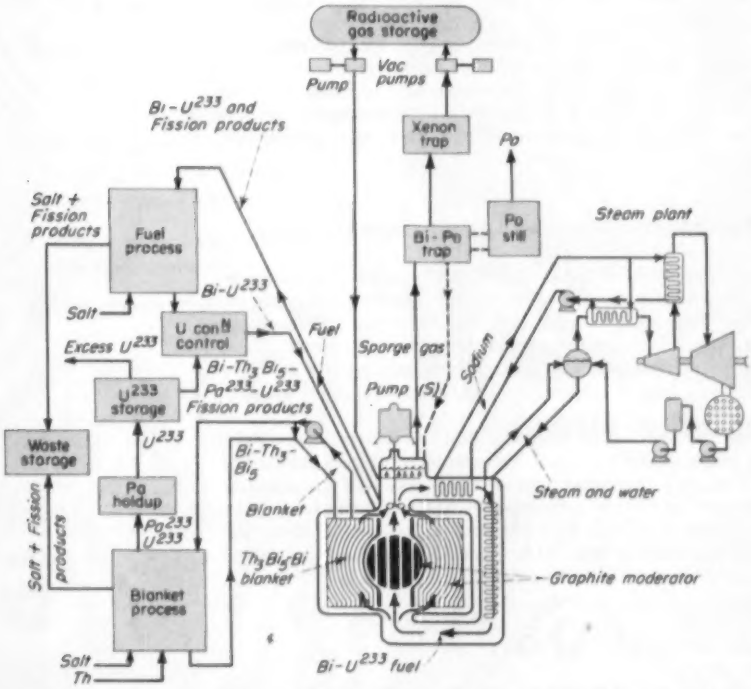
The homogeneous design has a large negative temperature coefficient of reactivity—when load decreases and system temperature tends to rise, reactivity decreases. Reactor cannot generate more heat than is being removed and average temperature always stays about 540 F for a fuel concentration of 9.6 grams of U-235 per kg of D_2O.

Full-scale plant. A commercial aqueous homogeneous-reactor plant is offered by Foster Wheeler Corp. It is rated at 100,000 kw; steam pressure is 600 psi (saturated). In addition to uranyl sulfate in core, there would be a blanket of thorium in heavy water (diagram above).

Canned-rotor pumps circulate fuel solution through core and steam-generating heat exchangers. Core connects to noncritical dump and storage tanks into which fuel solution drains for shutdown. At highest point of system,



CORE CONSTRUCTION for homogeneous reactor test (HRT) at Oak Ridge. Fuel solution is uranyl sulfate in heavy water. Blanket space will carry heavy water initially



LIQUID-METAL-FUEL REACTOR proposed by Brookhaven Lab: Fuel would be molten solution of bismuth and U-233, with graphite moderator. Processing steps are indicated

a pressurizer with electric heaters maintains desired system operating pressure (1200 psi).

Blanket circulates in a separate system with its own heat exchangers, canned pumps, and dump and storage system. About one-fifth of total reactor heat output comes from the blanket.

Processing. The plant would include a processing system for the core materials, to remove the majority of the gaseous and insoluble fission-product poisons as they form. Blanket material would be removed periodically for processing in an existing AEC facility. But it is anticipated that when reactors of this type are operating it will prove feasible to have a centrally located commercial processing plant for blanket material.

License application for a 150,000-kw homogeneous-reactor plant was recently filed by Pennsylvania Power & Light Co. This completely privately financed venture is slated for operation in 1962 with a Westinghouse reactor.

Liquid-metal fuel represents still another approach to the homogeneous idea. Extensive design studies by Brookhaven National Laboratory, evaluated for AEC by Babcock & Wilcox Co, suggest a fuel solution of bismuth and U-233, with graphite as moderator. There would be a thorium-bismuth blanket.

Proponents of this liquid-metal-fuel concept see for it the basic homogeneous advantages — simplicity and possibility of continuous reprocessing of fuel. In addition, use of liquid metal gives high heat capacity and possibility of high temperatures without high pressures.

Reactor core is visualized as a graphite structure with channels so arranged and proportioned that when liquid fuel is pumped into them, the mass becomes critical. Heat output would be controlled by concentration of uranium in the solution.

An exchanger in the fuel loop (diagram left) transfers heat at about 970 F to liquid sodium which supplies a superheater and reheater. Basic steam generation is accomplished in another exchanger further along in the fuel loop. Temperature after this "boiler" section would be about 660 F.

Chemical processing divides into two parts. One system removes fission products that are gaseous or have a fairly high vapor pressure, such as xenon and iodine.

Trapped bismuth vapors would be returned to the reactor. Radioactive xenon would be captured in a tank; it might prove a valuable byproduct.

A very small stream will be removed from the fuel system for chemical processing in a column with fused salts. Here, remaining poisons would be mostly oxidized out and go into the salt. Solution, clean of fission-product poisons, would return to the reactor. If necessary to add more uranium, it would be done at this point.

The breeder zone would also be a channeled graphite structure. The blanket mixture would be thorium suspended in molten bismuth. It will be processed for removal of uranium bred in the blanket. This will be available to feed back into the reactor.

What's ahead for nuclear energy?

We've seen that the building of nuclear power plants in what might be called commercial sizes has just begun. These plants are admittedly not competitive with today's conventional central stations. But from them we expect to learn how to build nuclear plants that will be economically attractive. How soon will this be and what rate of growth can we expect?

When will nuclear plants compete?

Forecasters differ in their estimates, as you might expect. And nuclear plants will be competitive in some areas—where fuel costs are high—before they become generally economical. Most forecasts put the point where nuclear plants prove generally competitive somewhere between 1965 and 1970. After that, they expect the rate of building nuclear plants to increase rapidly.

During this time, of course, total power demand will be rising also. Thus, even though nuclear capacity additions each year may be expected to increase sharply when they become widely competitive 10 to 15 years from now, it will take some time before the amount of nuclear capacity added each year equals annual additions to conventional capacity.

When will nuclear additions match conventional?

This key point is doubly difficult to forecast because it involves an estimate of total capacity as well as of nuclear capacity. But the indications are that some time between 1975 and 1980—say 25 years from now—the nuclear capacity added each year will equal the conventional capacity added. From that point on, forecasters agree, nuclear capacity added annually will exceed conventional capacity added by an ever wider margin.

Assuming that this outline of things to come is generally accurate, one important point should be noted. Growth in total demand during this period will be such that when—say in 1980—only half the capacity added each year will be of conventional type, this half will probably be more than twice the total yearly additions today. Briefly then, the familiar steam plant burning coal, oil or gas will be an important factor in the central-station power situation for many years to come.

What will future plants be like?

What the nuclear plants of the future will be like is, right now, anybody's guess. Remember that the first electric central station was designed for low-tension dc. It took more than 15 years, and endless experiment and debate, to appraise the merits of various systems and settle down to polyphase ac, the more or less universal system of today.

It is certainly too early to say which of today's reactor types hold most promise for the future. Or even whether tomorrow's reactors may not stem from concepts not yet explored. One thing can be said with assurance, however: The years ahead will be as exciting for power men as those when electricity was first coming into use. And they should be as fruitful of developments beneficial to all mankind.

Facts about PRU's new Mid-America home office

- First skyscraper in Chicago area in more than 20 years
- 601 feet high; Chicago's tallest roof top
- Tubular steel mast, TV antenna extending 324 feet above roof of building set new high point of 925 feet on Chicago sky line
- Over a million square feet of rentable space
- Cost, nearly 40 million dollars

To be dedicated this month:

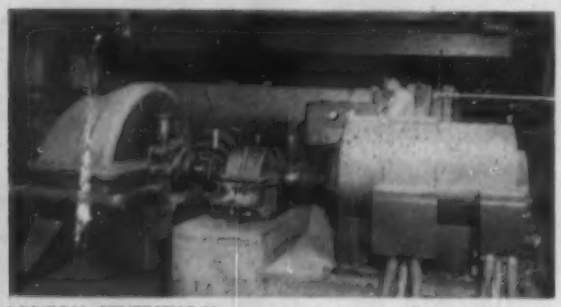
The Prudential Building...its power services are geared for big business

By R J HEINEN, *Manager*
Building Maintenance Division

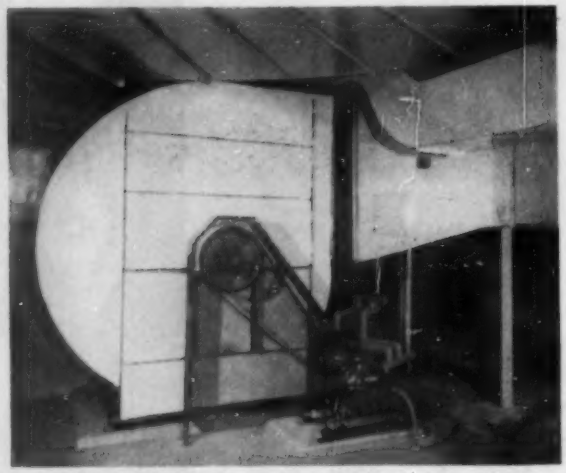
► TOWERING 601 FEET into the sky line, Chicago's new ultramodern Prudential Building, owned by The Prudential Insurance Co of America, is the last word in office facilities. And building services are one of the big reasons why.

Its 27 automatic high-speed elevators, year-round air conditioning, electrical distribution system, steam heating, fire-prevention and service-water systems—all represent the latest practices.

In each of the sections that follow we're going to look at the major systems, and see how they're planned to give Prudential and its tenants the best in building services. *Turn page*



900-TON CENTRIFUGAL compressor is one of three big units



AIR-SUPPLY FAN feeds conditioned air to building interior

Air conditioning . . . chilled water teams up with direct expansion

Different needs of building tenants, exacting temperature, humidity conditions called for special attention to conditioning methods. And results of careful study led engineers to choose a combination of techniques.

Three 900-ton motor-driven centrifugal compressors, photo above, left, cool the over-one-million square feet of rentable floor area. Two of these machines, with 440-v synchronous-motor drives, vary load with automatic suction dampers. Third, driven by 440-v variable-speed wound-rotor motor, is equipped with a manual suction damper. Wound-rotor and one synchronous-drive machine also have manual hot-gas bypass for added load variation.

Chilled water at 42 F, powered by three 100-horsepower pumps, circulates through building dehumidifier coils. Each 900-ton compressor produces 1700-gpm chilled water.

Special-purpose areas are conditioned by direct-expansion systems. These rooms were designed to be independent of chilled-water system, largely because they're occupied after regular business hours. Areas include: 66 tons for the observation deck, cocktail lounge and businessmen's club; 120 tons for the assembly hall and 200 tons for the restaurant.

Basically, methods of cooling interior bays and perimeter areas in warm weather are like those used in heating cycle.

Electronic business machines are an important item in Prudential's insurance operation. And heat load from these units requires extra cooling. One of the business-machine areas initially has 40 tons of additional package-unit cooling. So for greater flexibility here, plans called for three wet-column risers, more electrical capacity. Risers provide condenser water, waste and condensate drainage for all anticipated package units.

Since Prudential is so close to the Chicago River, they've run a 30-in. condenser cooling-water line into an intake chamber at the building instead of a cooling tower. Bar screen, at river, and traveling screen, before the chamber, filter cooling water. Gravity flow carries water to the building. Here, three pumps pick it up, deliver a total of 5400 gpm to refrigerant condensers. Two more pumps supply condenser water to direct-expansion units.

For immediate future, Prudential plans to install separate air conditioning, serving an electronic "brain" designed to handle insurance operations. A separate compressor and control system will serve the closely regulated round-the-clock load that's made up of electronic components.

Even the elevator machine rooms come in for special cooling of their electronic components. Some 80-F air, normally exhausted from rentable areas to the outside, passes through machine rooms. Also, thermostatically controlled package units supplement this setup on really hot days.

Water services . . . now and in the future

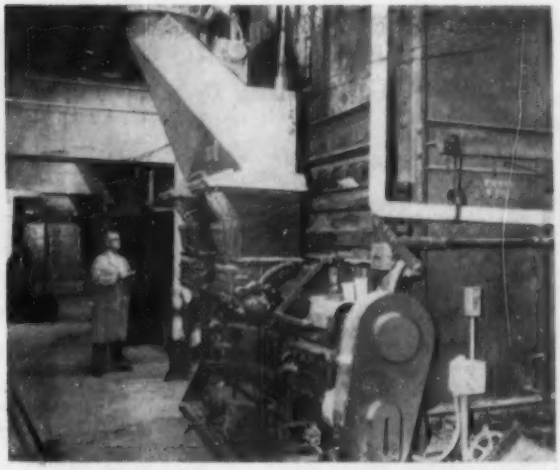
By splitting up house-water system into three sections, Prudential was able to put an economical ceiling on maximum system pressure, keep pumping, piping costs down. One section serves areas below 18th floor. Another supplies upper floors. Also, 2-pump pneumatic tank system, on the 40th mezzanine floor, handles top floors.

Meters ahead of 3rd-basement house pumps keep a close check on water use. These pumps lift water to three 18th-floor house tanks. From here, water splits up to (1) provide gravity feed for lower floors (2) be pumped to two house tanks on the 40th mezzanine floor. Floats, in water columns, off tanks control all house pumps.

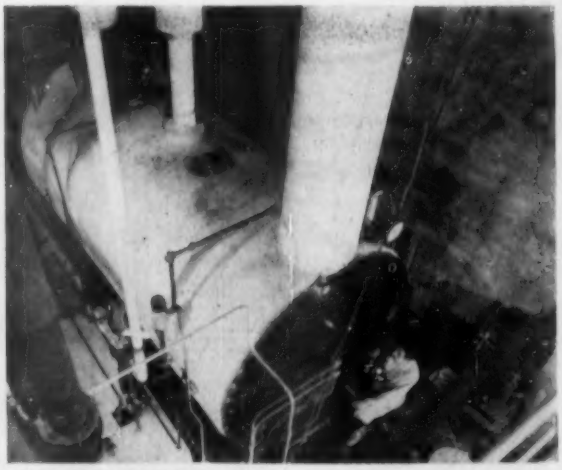
In nonheating season, steam from the small gas-fired boiler supplies restaurant and low-cost hot water for house system. Steam, in copper-lined steel tanks, heats hot water in 3rd basement, on the 18th floor and on the 40th mezzanine floor. Gravity feed from house tanks to heaters supplies enough head to create upfeed through heaters. From here, house hot water rises to two floors below house tanks supplying down-feed system.

A typical rentable floor has six wet-column risers furred around building columns: hot water, cold water, waste, vent. These give the building service flexibility by permitting remote lavatories and drinking-water coolers in tenant areas.

Central refrigerated drinking-water system with sand and gravel filter serves floors occupied by Prudential. Tenant drinking water comes from wet columns, through refrigerated cabinet fountains.



COAL-FIRED BOILERS are equipped with spreader stokers



GAS-FIRED BOILER supplies the steam for process heating

Steam heating . . . coal carries the main load

Reliable heating to serve a broad range of conditions: That's what the Pru needs for its year-round air conditioning. Here's how they're getting it:

Four 125-psig boilers, three coal fired for space heating, one gas fired boiler for process-steam supply to risers and using areas throughout the building. Two of the coal-fired boilers generate 40,000-lb-per-hr steam, one supplies 22,000 lb per hr.

Dual-drive spreader stokers, photo above, fire the three big boilers. Engineers also fitted each boiler with a skimmer baffle and centrifugal separator to remove flyash. Cinder reinjection system boosts combustion efficiency, helps clean flue gas.

Coal handling. Since Prudential is built on air rights atop Illinois Central and Michigan Central railroad tracks, coal comes into the building via track siding. Belt feeder moves coal from the hopper to a loop bucket conveyor that discharges over active bunkers. A coal elevator can transfer coal to dead storage when active bunkers are full. To return dead storage to main flow, belt conveyor delivers stored coal to the loop bucket, feeding active bunkers. Three coal scales keep watch on coal consumption.

Ash handling is an efficient carefully planned operation at Prudential. A steam-ject vacuum exhauster carries ash from pits and dust collectors to hopper. A bucket elevator then lifts ash from the hopper bottom to a rotary dustless unloader for discharge to railroad cars.

The coal-fired boilers can also burn No. 6 oil for alternate fuel firing. Completing the equipment picture for steam generation are pneumatically operated combustion controls, 2-element feedwater regulators and soot blowers.

Condensate gets back to boilers via vacuum and condensate-return pump sets, each equipped with two pumps—one motor, one turbine driven. Smart layout on feedwater side of the system also includes: (1) tray-type deaerator for heating, oxygen removal (2) chemical treating to protect boilers, prevent return-line corrosion (3) motor, turbine-driven boiler-feed pumps.

Space heating is part of the year-round air conditioning. And engineers split it up into three different systems:

1. For interior bays of rentable areas, fan system blows air over steam coils, feeds warm air, through ducts, to ceiling diffusers. (Cooling distribution uses same system.)

2. More than 2600 units, one at each window, can heat or cool perimeter areas of rentable floors. High-velocity air from ten high-static-pressure fans (10-in. wg) feeds each unit through round ducts. As fan air passes up through a window unit, it induces room air to enter unit, blends with it. Units' coils get hot water from steam-to-water converters via four dual-drive pump sets on 9th, 19th, 27th, and 40th mezzanine floor. Unit coils pass chilled water.

For economical winter operation ,high-velocity fans run in daytime only. Coils receive 110-F water during day. But at night, automatic switchover jacks up water temperature to 180 F, heating perimeter areas by natural convection alone.

Thermostatic controls can regulate water flow through one or several unit coils. Single-stat control operates in private offices. Control in clerical areas is by stats serving groups of window units. Here, only the building staff can get at control knobs.

3. Toilets, powder rooms, stairwells are heated by standard convectors, fin-tube radiation.

Temperature controls are designed for remote reading at a central panel in engineer's office. The engineer can also correct space temperatures directly from his panel.

Control valves, dampers operate off air signals. But an electronic-pneumatic relay handles remote position correction electrically. Two compressors supply needed control air.

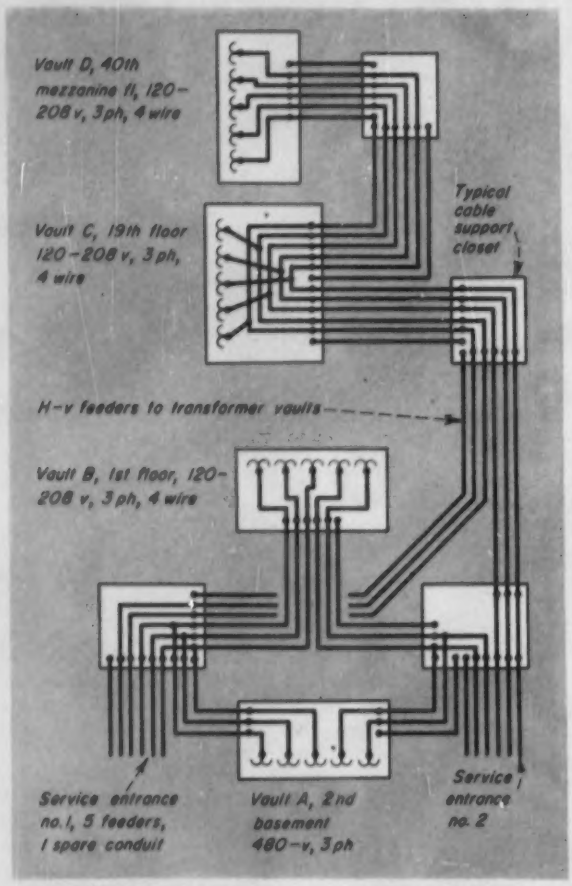
Vertical transportation

Fully automatic, nonattendant. That's the big feature of Prudential's 30 fast elevators. Four of these (high-riso passenger cars) travel at 1400 fpm—fastest in the world.

Freight elevators (two units) can handle 6750 pounds each. And one has additional equipment that allows it to exceed normal load by one third.

Other vertical transportation: Of twelve 120-fpm escalators, four are the highest ever built and rise two flights from top passenger elevator terminal to the observation deck.

Turn page


Vault D, 40th mezzanine fl, 120–208 v, 3 ph, 4 wire
Typical cable support closet
Vault C, 19th floor 120–208 v, 3 ph, 4 wire
H–v feeders to transformer vaults
Vault B, 1st floor, 120–208 v, 3 ph, 4 wire
Service entrance no. 1, 5 feeders, 1 spare conduit
Vault A, 2nd basement 480–v, 3 ph
Service entrance no. 2

12-KV PRIMARY feeds power to the building load centers

Electrical distribution . . . it's 12-kv for the primary feeders

Four transformer vaults at key points throughout the building step down 12-kv incoming electrical power for Prudential, diagram, above.

Vault A, in 2nd basement, has a 480-v secondary for main motor drives. Vaults B, C and D, on 1st, 19th and 40th mezzanine floors, are 110-208 v, 3 phase, 4 wire, for lighting, office power and mechanical equipment drives.

Carrying power throughout the building are seven electrical shafts serving lower stories (through 10th floor), three shafts supplying tower floors. And for telephone, signal and intercom, three low-tension shafts serve lower stories, one 1-t shaft feeds tower floors.

Ultramodern electrical design of cellular steel underfloor system permits electricians in future to set a power or telephone outlet on almost any square foot of rentable office area. In brief, the underfloor system, using electrical fittings, divides into a 2-duct arrangement, using every other cell for power and alternate cells for telephone, intercom. And cells are on 6-in. centers.

Other electrical features include a central IBM clock system and programmed music for areas used by Prudential. Music circuit also doubles as public-address hookup.

PRINCIPAL BUILDING-SERVICES EQUIPMENT

The Prudential Building, Chicago, Illinois

STEAM-HEATING EQUIPMENT:

Boilers, 3 ..... Erie City Iron Works
Two, model 4VC. One, model 3VC. Two-drum bent-tube boilers with integral watercooled furnaces. 125 psig, coal and oil fired. Two, 40,000 lb per hr. One, 22,000 lb per hr
Boiler, 1 ..... Cleaver-Brooks Co
Gas fired, model LR 700-25, 250 bhp, 125 psig
Spreader stokers ..... Detroit Stoker Co
Dual-drive rotostokers
Oil burners, 6 ..... Peabody Engineering Corp
Four units, M-18, 2 units ML-12
Soot blowers .... Copes-Vulcan Div, Continental Foundry & Machine Co
Forced-draft fans, 3 ..... Clarage Fan Co
Deaerating heater, 1 ..... Chicago Heater Co
80,000 lb per hr, tray type, model L-80
Coal-handling equipment ..... Link-Belt Co
Coal scales, 3 ..... Stock Equipment Co
Ash-handling equipment ..... Pettibone Mulliken Corp
Feedwater regulators ..... Copes-Vulcan Div, Continental Foundry & Machine Co
Combustion controls ..... Republic Flow Meters Co
Condensate-pump set ..... Chicago Pump Co
Vacuum pump set ..... Nash Engineering Co
Feedwater treatment ..... Dearborn Chemical Co

AIR-CONDITIONING & VENTILATING EQUIPMENT:

Refrigeration compressors, 3 ..... Carrier Corp
Centrifugal units, 900 tons each
Direct-expansion systems ..... Carrier Corp
Packaged air conditioners ..... Carrier Corp
Conduit Weathermaster units ..... Carrier Corp
Cooling coils ..... Carrier Corp
Filters ..... Farr Co
Air-handling fans ..... Sturtevant Div, Westinghouse Electric Corp
Air outlets, grilles, registers ..... Tuttle & Bailey Co
Condenser-water pumps, Chilled-water pumps, Secondary-water pumps ..... Buffalo Pump Co
River-water intake screen ..... Link-Belt Co
9000 gpm, traveling screen
Temperature controls ..... Minneapolis-Honeywell Regulator Co

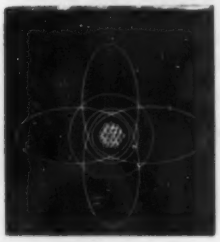
ELECTRICAL EQUIPMENT:

Circuit breakers ..... I-T-E Circuit Breaker Co
Bus duct ..... Bulldog Electric Products Co
Motor-control centers ..... Cutler-Hammer, Inc
Underfloor system ..... General Electric Co, H H Robertson Co
Assembly-hall and stage lighting switchboards .... Major Equipment Co
Standard lighting fixtures ..... Daybrite Lighting, Inc
Lamps ..... General Electric Co
Fire-pump motors ..... Marathon Electric Mfg Corp
Fan and compressor motors ..... Westinghouse Electric Corp
House-pump motors ..... Fairbanks, Morse & Co

MISCELLANEOUS EQUIPMENT:

Instrument air compressors, 2 ..... Worthington Corp
Elevators, 30 ..... Otis Elevator Co
27 passenger; 2 freight; 1 service; automatic, nonattendant
Escalators, 12 ..... Westinghouse Electric Corp
House pumps, 7 ..... Economy Pumps, Inc, div of C H Wheeler Mfg Co
Three, 500 gpm. Two, 175 gpm. Two, 40 gpm
Sump-pump sets, 2 ..... Weil Pump Co
Each duplex: Two, 500 gpm. Two, 100 gpm
Fire pumps ..... Peerless Pump Div, Food Machinery & Chemical Corp
House tanks, 6 ..... Independent Boiler & Tank Co
Hot-water heaters, 3 ..... Richmond Engineering Co, Inc
Two, 2000 gph. Two, 750 gph. One, 200 gph
Pneumatic ejector ..... Yeomans Bros Co
Plumbing fixtures ..... American Radiator & Standard Sanitary Corp
Piping ..... National Tube Div, U.S. Steel Corp

Architects and Engineers ..... **Naess & Murphy**



Nuclear notes

By B G A SKROTZKI, *Associate Editor*

Three 10,000-kw nuclear plants will soon be ordered for installation in Latin American countries by American & Foreign Power Co. This U. S. holding company controls power networks in 11 countries. The three reactors will each be of different types made by different builders. Guesses indicate that the plants will probably be erected in Brazil, Cuba and Mexico—not confirmed by A&FP Co.

Gases at millions of degrees temperature will be ionized because their molecular velocities cause them to lose their electrons. This will be the condition in thermonuclear reactions (fusion). So H D Smyth of Princeton University suggests that since we can't build containers to hold these temperatures, maybe we can confine the gases by electric and magnetic fields. Just how we take out the energy is one of the major puzzles of putting fusion to useful work.

Evaluation of reactor dangers by the AEC Advisory Committee on Reactor Safeguards mostly consists of judging the basis that reactor designers themselves use in estimating the hazards in their designs. They make sure that all angles have been considered by the designers—the Committee doesn't set up reactor design standards comparable to the Boiler Safety Code.

Five lines of defense against reactor accidents are considered by Reactor Safeguards Committee: (1) safety control rod operation (2) reactor stability as measured by negative temperature coefficient and void formation in the coolant (3) strength of reactor tank to hold pressurized vapor and gases from boiling coolant and melting fuel (4) strength of building to resist and hold pressures of gases and vapors escaping from ruptured reactor tank (5) plant exclusion area.

A 25-year search ended on October 17 when a team of scientists at the AEC's Radiation Laboratory at the University of California confirmed the first observations of the anti-proton (negative proton) on September 21st. The $9.5 million Bevatron at this lab made the discovery possible. Theoretical physicists have predicted the existence of this sub-atomic particle for the last quarter century. Cosmic ray researchers have been on the lookout for it but never found it.

Acceleration to 6.2 billion electron volts energy of a stream of protons starts the process of producing anti-protons. Aimed at a copper target, some of the protons slam into Cu nuclei. For every proton hitting a neutron in a Cu nucleus, the original proton, the struck neutron, another proton and an anti-proton charge out. In the collision, part of the bombarding proton's energy converts to the mass of the latter two particles; this follows Einstein's theory. An analogous condition happens when a gamma ray of high energy passes close to a nucleus and converts to a negative and positive electron (positron).

Mass changes to energy to give us heat in our everyday and nuclear processes. Now we know of two of these processes taking place outside of a nucleus—(1) When an electron and positron combine they disappear to form a gamma ray of lower energy than the ray that formed the positron initially. (2) When a proton and anti-proton combine they decay into mesons which disappear as energy. Anti-protons do not exist in nuclei of atoms but are born of high-level energy, "live" outside the nuclei.

Powdery like fine sand, fluid coke promises . .

- **Easy handling without static or sparking problems**
- **Better mechanical-precipitator performance, helping to reduce air pollution. Electrostatic type also usable**
- **Simple reinjection of precipitated material into boiler**
- **Costs comparative with coal, oil and gas, on a Btu basis**

Fluid coke, newest steam-plant fuel, passes tests, shows possibilities

By F H STRACKE, *Esso Research and Engineering Company, and*
F H SCHIFFER, *Public Service Electric and Gas Company of New Jersey*

► THE POWER INDUSTRY is showing much interest today in test burnings of a new fuel known as *fluid coke*. This article reviews the program of Esso Research and Engineering Company in its studies to determine the adaptability of fluid coke for steam generation, including full-scale combustion tests recently finished at the Essex Station of Public Service Electric and Gas Co.

Refining process. For many years there has been a continuous increase in world-wide consumption of gasoline, heating oil, jet fuels and other light petroleum products. While the market for heavy fuel oil has increased, the rise has not been as rapid as for light products. In addition, there has been a trend toward processing heavier crudes.

Resulting market demand for petroleum products was much different from the product distribution obtained by simple distillation of crude oil. In the early forties, Esso Research and Engineering Co, formerly Standard Oil Development Co, developed fluid catalytic cracking. This process aided the refiner by allowing him to upgrade gas oil to gasoline and other lighter products. But as consumption of light products continued to increase, not even fluid catalytic cracking could meet the need.

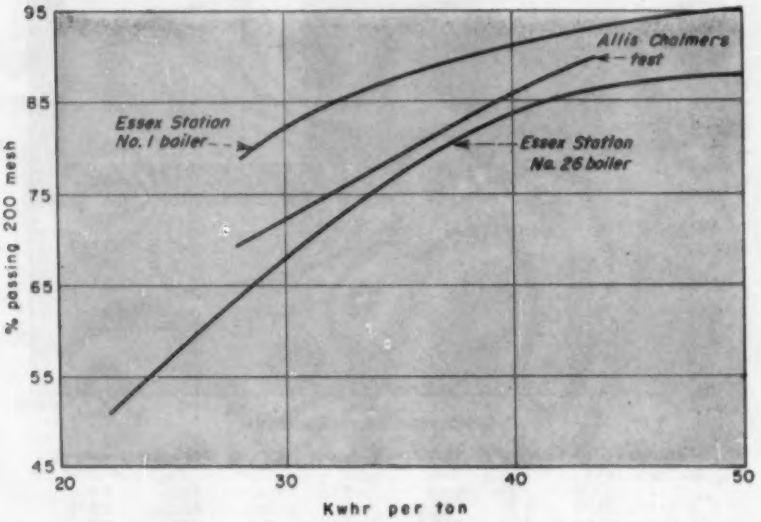
Fluid coker. All these factors created a real need for a refining process to upgrade heavy fuel oils to lighter products. Though vacuum distillation has been widely used, it does not give enough reduction in heavy fuel. Delayed coking can be used, but it is not a continuous process and cannot be applied to all types of crudes and heavy fuels.

About five years ago Esso started an extensive program to develop a new process that would enable refiners to meet today's demands. The result of this program was the **fluid coker.**

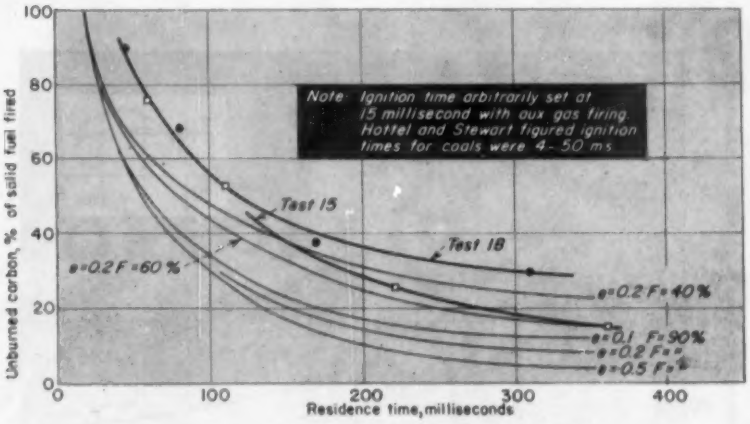
Possibilities. About two years ago Esso became active in a project to determine ways and means of best using this new product. Because refiners who adopted the fluid coking process would be faced with the problem of moving large volumes of carbonaceous material new to the industry, a long-term development program was established. Early studies showed the material was useful as a fuel, primarily for steam generation. So we had to learn how it could best be used.

At that time the total supply of fluid coke in the world was about 10 tons, from pilot-plant operations. We realized that the usual volume-burning cut-and-try technique, so familiar to the fuel industry, would not apply in this instance. So our second problem was developing this material as a fuel while having little of it to work with.

Studies. A 4-part program was established to cope with this situation.



1 Power requirements of Foster Wheeler ball mills, *upper and lower curves*, and a laboratory mill, *center curve*. The experimental and actual tests agreed well



Source:	Fuel	primary	aux	% excess air, e	% thru 200m	Preheat F	Avg. temp. of comb. gas
calculations using Hottel-Stewart combustion curves	Fluid coke	35 %G		10	90	-	2450
	"	"		20	"	-	"
	"	"		50	"	-	"
	"	"		100	40	-	"
Test No. 15 □	"	"		20	60	-	"
No. 18 ●		14%G		-20	90	450	2275
		35%G		-2	60	450	2450

2 Theoretical unburned carbon vs residence time for various excess-air values and different finenesses of fluid-coke grinds—calculated and test-run results

1. Theoretical combustion calculations were made, based on work by Professor Hottell and Mr Stewart, both of Massachusetts Institute of Technology. Adopting their techniques, equations and personal advice, we concluded that here was a material usable in large boiler furnaces as a pulverized fuel, provided the furnaces were operated much as for anthracite coal. At first this was discouraging for it was realized that little anthracite is burned in large boilers. But there was enough evidence to show that the material could be burned in pulverized bituminous-coal furnaces.

2. Laboratory-scale tests, using the methods of Sherman at Battelle Memorial Institute, were the second part of the program. Only a little more than four tons of coke were finally used during these tests.

3. Pilot-plant scale tests were proposed, should the lab tests bear out the theoretical calculations. More samples would then be available from the pilot plant.

4. Last step in the program was to make full-scale tests when enough coke was available.

Timing. At the start of this program it was known that by about January 1955, the first fluid-coking units would be operating at the Billings, Mont., refinery of Carter Oil Co. So we planned to have the laboratory and pilot-plant operations well under way by this time, to permit full-scale testing with a minimum loss of time.

Timing was such that the first full-scale test was recently completed. It can now be said without reservation that this material is completely usable as a fuel in modern furnace installations. About 1000 tons have been successfully burned in the boilers of Public Service Electric and Gas Co.

Properties. Table I, p 105, shows a few of the physical properties of the material from the pilot-plant operation. The last column gives the physical properties of the material now obtained from full-scale operations. You can see that fluid coke is low in hydrogen content, compared to a high or a low volatile coal. Carbon content is about 84.8%, comparable with both high and low volatile coals.

Sulfur in this sample is about 7.7%, compared to 0.6 and 0.7% for the two comparative coals. But it does not necessarily follow that the sulfur content of all fluid coke will be as high as the tabulated values. Coke represented by this sample was formed from a high sulfur-bearing crude. Should coke be formed from sweet crudes, the sulfur content would be lower. In actual field operations at Billings, sulfur content runs about 5.2%.

Table I also shows the size analysis of the material produced by the pilot plant. Much of it is in the range of 30 to 100 mesh. Theoretical calculations showed the material would probably have to be pulverized to make it serve as a fuel.

Grinding characteristics were investigated at Battelle, with full-scale grinding tests being made in the research labs of Allis-Chalmers Manufacturing Co, in Milwaukee, Wis. Both conventional rotating ball mills and the vibrating ball mill, a recent A-C development, were used in the tests. Fig. 1 shows the results. Other manufacturers of grinding equipment ran sim-

ilar tests. All indicated that the power required to grind fluid coke was 2 to 2.5 times that for a standard 55 Hardgrove coal to the same fineness. Actual field tests have verified these results remarkably well.

Theoretical effects of fineness of grind and excess air on the burning rates of fluid coke are shown in Fig. 2. Sherman's application of his work to earlier test data on coal firing in a similar furnace was used to prorate, on the basis of physical characteristics of the coals and fluid coke, the performance of coke under similar combustion conditions. In our laboratory work, we met these original predictions closely. Two actual test burnings are plotted for comparison on Fig. 2.

Correlations, at first glance, indicate the predictions are somewhat optimistic. But after adjusting for differences in excess air, ignition time and combustion temperature between test data and predictions, the test results correlate fairly well.

For example, reducing the unburned of test No. 15, to allow for an increase in excess air from −2% to +10%, alone brings these data into line fairly well with predictions. The time for ignition after coke has entered the furnace appears to be about the same as the assumed ignition time of 15 milliseconds, as evidenced by the curve's projection to the 100% unburned point, Fig. 2.

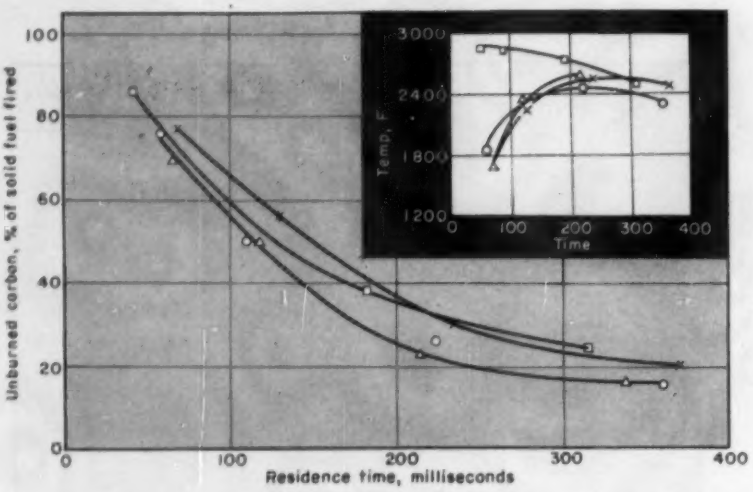
Curve of test No. 18 indicates the ignition time was somewhat longer. This is reasonable, as the coarser coke, 60% through 200 mesh, would take longer to heat to its ignition temperature. The theoretical curves will displace to the right for greater ignition time. No attempt was made to reflect the ignition-time difference in the predictions for various fineness of coke.

Data, used in compiling all test results, were calculated by the carbon-balance method. In most instances the dust-sampling method gave considerably lower unburned-carbon values. If the dust-sampling technique were reasonably accurate, a combustion-air metering inaccuracy or an orsat sampling leakage could account for the discrepancy.

Unburned carbon. Effect of auxiliary fuel on unburned carbon is shown in Fig. 3. In this case the auxiliary fuel was gas and the increase in unburned carbon can be explained by the fact that gas utilizes its theoretical air almost immediately. Most of the coke burning is, therefore, carried on in an atmosphere of a lower oxygen partial pressure than when less auxiliary gas is used at the same total excess air. Unburned carbon for test No. 14 would be even greater, relative to the other tests, if its combustion temperature and excess air were in line with the other tests.

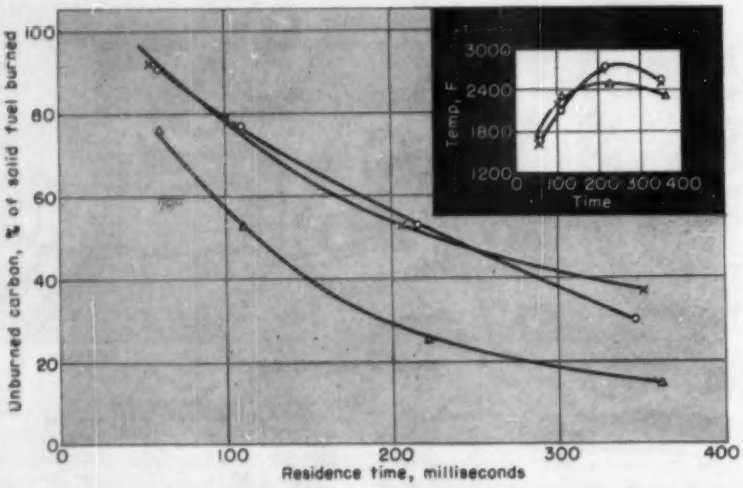
Since fuel oil and coal burn at lower rates, this effect is known to be much less when utilizing them as auxiliary fuels. Even though the unburned coke increases with a greater percentage of auxiliary gas, the unburned in terms of total fuel fired tends to cancel the effect, lessening this factor in pollution.

Fig. 4 shows the effect of fineness of coke grind on unburned carbon. Size distribution of coke fired for the 40-and-60%-through-200-mesh tests could possibly account for the crossing



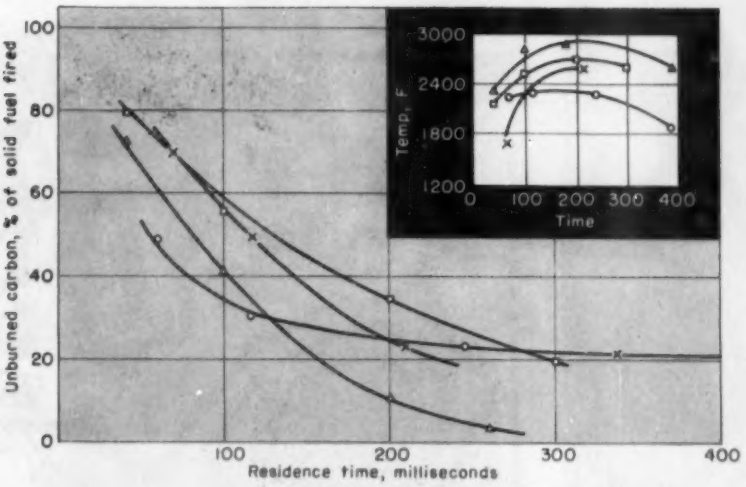
Source: Battelle test		Fuel Primary	Aux	% excess air	% thru 200m	Preheat F	Avg temp of comb gas
11	△	Fluid coke	None	−3	90	450	2300
15	○		14% G	−2	90	450	2275
12	×		32% G	0	90	450	2300
14	□		67% G	9	90	450	2760

3 Unburned carbon vs residence time for various percentages of auxiliary fuel used in tests performed at Battelle for Esso Research and Engineering Company



Source: Battelle test		Fuel Primary	Aux	% excess air	% thru 200m	Preheat F	Avg temp of comb gas
15	△	Fluid coke	14%	−2	90	450	2275
19	○		15%	0	60	450	2290
20	×		16%	−6	40	450	2310

4 Unburned carbon vs residence time for various degrees of fineness of the fluid coke, as determined by three tests with different auxiliary-fuel percentages



Source: Battelle test		Fuel		% excess air	% thru 200m	Preheat F	Avg temp of comb gas
		Primary	Aux				
23+	□	Semi-anth (8.7)	–	17	85	600	2500
26+	△	Pocahontas (13.9)	–	22	85	600	2600
13	○	Lvc	(20%) –	-5	60	450	2600
11	×	Fc	(5%) –	-3	90	450	2300

5 Unburned carbon vs residence time for various fuels—excess-air percentage was different for each test, with a high value of 22% and a low value of –3%

I: Coal and coke analyses for combustion tests

	COAL		COKE	
	High volatile	*Low volatile*	*Pilot plant*	*Full-scale unit**
Ultimate Analysis				
Carbon	75.4	83.5	84.80	87.30
Hydrogen	5.0	4.6	1.7	2.42
Sulfur	0.6	0.7	7.7	5.17
Oxygen	7.8	4.3	4.2	3.25
Ash	10.1	5.9	0.80	0.30
Nitrogen	1.1	1.0	0.8	1.57
Btu per lb				14,125
Specific gravity				1.4
Size analysis				
Retained on 16 mesh			3.25	5.42
Retained on 30 mesh			8.92	1.81
Retained on 50 mesh			58.08	18.77
Retained on 100 mesh			28.28	43.80
Retained on 200 mesh			0.74	25.06
Passed 200 mesh			0.73	5.14
Ash-fusion temperature				
Red's atmos, initial-deformation				2870
softening				2900+
fluid				2900+
Oxide's atmos, initial-deformation				2450
softening				2530
fluid				2580

*Data supplied by Babcock & Wilcox Company

Analysis of coke and its refuse

Proximate analysis (as received)	*Pulverized coke*	*Coke refuse*
Moisture, %	0.30	—
Volatile matter, %	6.75	2.00
Ash, %	0.30	2.55
Fixed carbon, %	92.65	95.45
Sulfur, %	5.15	4.67
Btu	14,111	13,265
Reactivity $T_{10\,C}$	348	411
Specific gravity	1.4	1.582

Data supplied by Foster Wheeler Corporation

of the burning curves in the earlier stages of combustion.

Burning rates of two coals tested by Battelle for another project are shown in Fig. 5. Data indicate that, in general, the 90%-fine coke burns considerably better than semi-anthracite at 85% fineness when excess air is taken into account. But it does not burn quite as well as a low-volatile bituminous coal. Based on this and similar tests, it was decided that fluid coke did not require conventional anthracite furnaces.

Unburned carbon levels in all these curves are higher than would normally be expected in a full-scale furnace because of the shorter combustion time used in test furnaces. Full-scale tests show the carbon losses are not as great as those in the curves here.

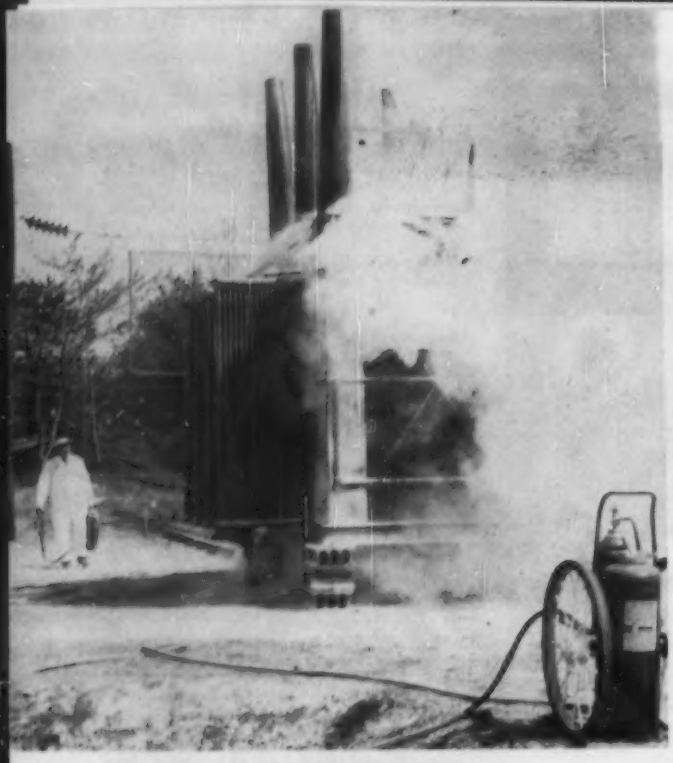
Boiler manufacturers became interested in coke fuel during the program at Battelle. Several small-scale tests were conducted at various locations throughout the country. Though the tests showed the coke was burning, data collected were incomplete.

Full-scale tests. With the program at Battelle near completion and the start of the first fluid unit nearly a reality, it became desirable to plan full-scale tests. Arrangements were made with Public Service Electric and Gas Company to conduct these tests at their Essex Generating Station. By early March, 1955, 500 tons of coke, transported in hopper-bottom cement cars, were received at the Essex Generating Station. The coke was unloaded and transported to bunkers through the existing coal-belt-conveyor equipment, which has inclines as high as 20 deg. No serious difficulties were encountered. For coke operation, however, the conveyor capacity is reduced to about one half. For continuous operation dusting may be a problem at transfer points.

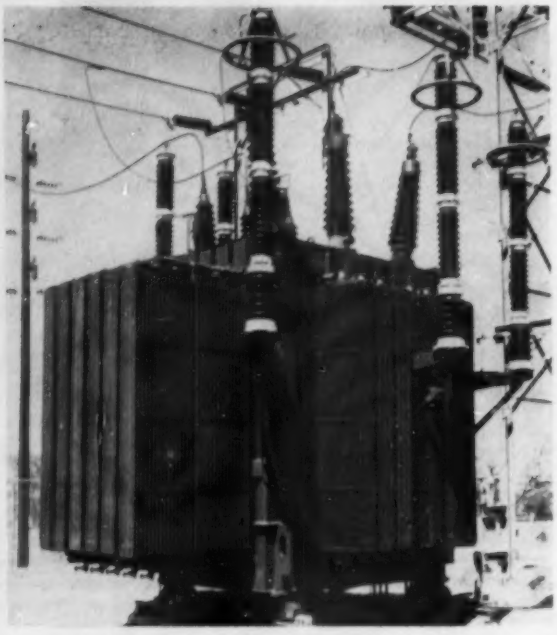
Because the effect of the new fuel on an actual boiler was unknown, a Babcock & Wilcox 605,000-lb-per-hr 1475-psig 950-F radiant-type unit was chosen for the first tests. This boiler, No. 26, was installed in 1938. Over-all heat-release rate is 27,000 Btu per hr per cu ft. The boiler is equipped with air heaters, economizer and electrostatic precipitators.

Pulverized fuel is supplied by two Foster-Wheeler Type D-5 ball mills, each feeding three B&W multiple-finger intertube burners, which downfire into the primary furnace. Before start of the tests this boiler had been oil-fired for a number of years. Early test runs were made on this unit to check the ability of the auxiliary equipment, feeders and ball mills—to handle fluid coke and to

(*Continued on page* 198)



Test fire in this mock-up of . . .



transformer installed in dry location . . .

One trained man + semifixed system =

► ONE MAN can quickly and effectively extinguish a major transformer-insulating petroleum-oil fire on the cover of a tall transformer. Unit must be equipped with a properly designed tank-mounted fixed-nozzle system to which the man can connect a conventional wheeled dry-chemical extinguisher.

This is the major conclusion of a report just released by E F Weaver, Superintendent of Tests, Pennsylvania Power and Light Co. His tests were made on a mock-up of a 50,000-kva 132/66-kv transformer, set up at the company's Hazleton, Pa. fire-test grounds.

Tests had been conducted over a 3-year period. Problem was to find an adequate means of fire protection for transformers at substations where (1) there was no water at all or (2) cost was considered excessive for providing sufficient water at suitable pressure to operate hydrant and hose systems, with or without the conventional types of deluge spray systems.

Working with representatives of the Ansul Chemical Co, Weaver designed a semifixed dry-chemical extinguishing system. He had these aims in mind: (1) System should be simple, inexpensive and reasonably foolproof. (2) Using the system, one trained operator, working alone, should be readily able to extinguish a hot, sizable transformer fire from the ground. (3) System should not require any special equipment other than nozzles and piping, and it should operate from existing types of portable fire-protection equipment normally available at larger stations.

NEED FOR PROTECTION

Fires admittedly occur infrequently on large, modern high-voltage power transformers. But when they do occur, the consequences may be serious.

Transformer bushings are recognized as the weakest link of the complete unit. So the most likely place for fire is on the transformer cover following a bushing failure. If enough oil is ejected at point of failure, side and ground fires may also result.

Similar serious fires may be caused by ruptured bushing or cover gaskets, or the release of flaming oil through pressure-relief vents following winding or other internal failure.

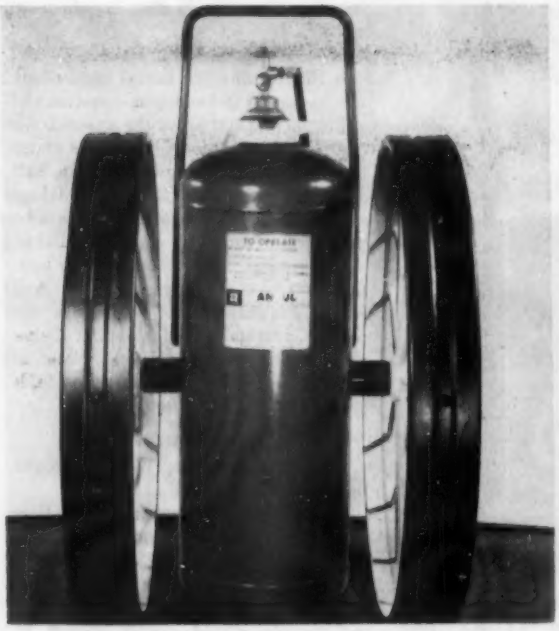
Cover fires on tall transformers are out of range of portable hose streams and wheeled-portable or hand-portable fire extinguishers operated from ground level, regardless of the type of extinguishing agent used. Spill fires covering sides and ground only can be extinguished readily from ground level by one or two men using the right size of portable equipment. But fires in high covers require fixed extinguishing equipment unless suitable elevated walks or ladders and more well-trained men are readily available.

Conventional types of automatic fixed fire-protection systems using water, CO_2, foam or dry chemical and designed for complete protection of top, side and adjacent ground-fire areas are more expensive. Hence the need for a semifixed system.

SYSTEM DESIGN

Weaver tried several pipe and nozzle arrangements before coming up with the 16-nozzle tank-side system that worked so well in the final tests last May. Previous systems had used fewer nozzles, and nozzles in different locations on and away from the tank sides. Earlier tests also involved different sizes of extinguishers and a variety of types of nozzles.

Sketch, p 107, shows the final de-



is extinguished by dry-chemical unit . . .

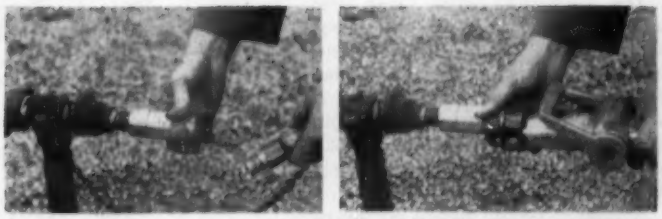
connected to pipe and nozzle system

fire protection for large transformers

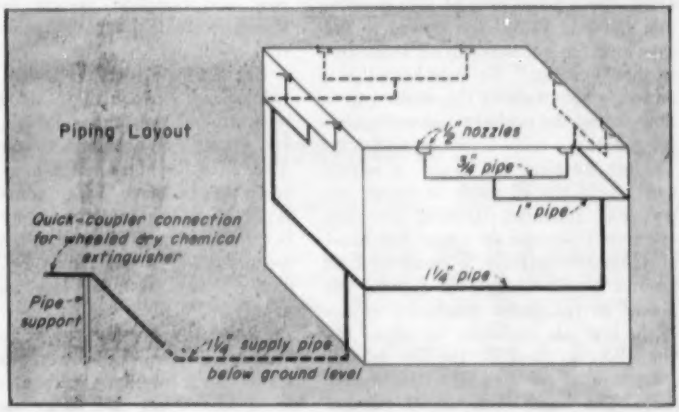
sign. The supply pipe has a quick-coupler connection for an *Ansul 350B* wheeled dry-chemical extinguisher. Piping connects to sixteen ½-in. type *F-1 Ansul* nozzles, arranged four on each side of the transformer tank. Eight nozzles are aimed horizontally, to cover a top or pan fire. Eight identical nozzles are aimed vertically downward to cover the sides and radiators of the transformer shell, and possibly handle ground fire as well.

Special ball valves, screwed pipe and hose connections, bursting disks, etc, used during previous tests are eliminated by the quick coupler. The male fitting is inserted in the discharge outlet of the standard extinguisher nozzle, and the female fitting in the supply pipe of the fixed system. Size of the main supply line is sufficiently small to increase velocity of the dry chemical enroute to the nozzle.

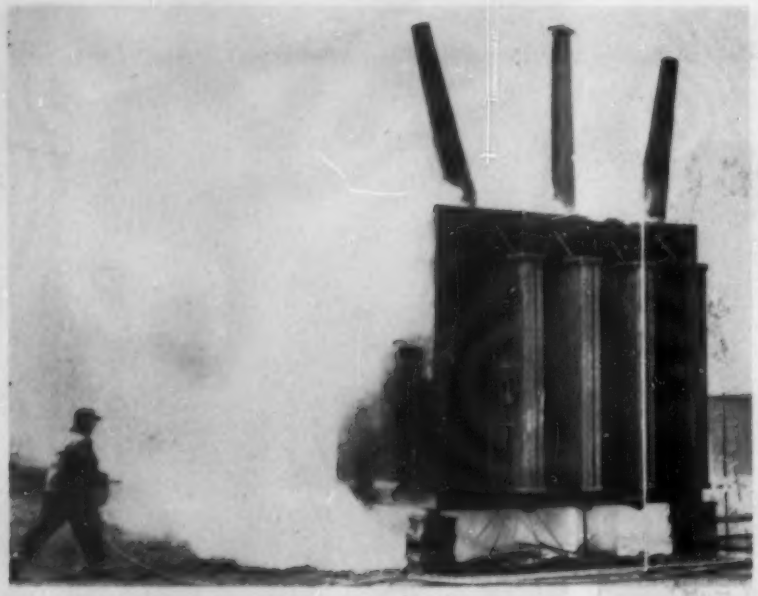
System is operated by a 4-step sequence: (1) Pressurize dry-chemical unit by opening nitrogen cylinder valve. (2) Unrack and run out full length of hose (50 ft). (3) Remove plug and insert hose-nozzle quick coupler into supply-pipe coupler. (4) Open hose nozzle. (Pressure built up during oper-



Quick-coupler unit. Removing pipe plug, *left;* connecting nozzle, *right*



Piping layout shows nozzle spacing around transformer tank. Eight nozzles aim horizontally across tank cover, eight others aim downward vertically



Ground assistance knocks out side and ground fires as piped system kills fire on top of transformer tank in this test on mock-up of 50,000-kva 132/66-kv unit

ations listed at (2) and (3) makes the use of a bursting disk unnecessary.

In tests run with this arrangement, the fire was completely extinguished with only occasional assistance from ground level.

FINAL TESTS

The mock-up's center "high side bushing" is made of sheet steel. It was used as a reservoir to store hot transformer-insulating petroleum oil (about 260 F) pumped to it from an oil preheater on the ground. This reservoir, in turn, supplied hot oil, through small openings near its base to a one-inch-deep pan on top of the mock-up.

As soon as enough oil had overflowed the pan to partly cover side and ground areas, the top was primed with gasoline and ignited. Initial fire served to further heat the hot makeup oil remaining in the "bushing." So only hot oil was added in maintaining the desired overflow during the preburn and extinguishing periods.

After burning for about a minute and a half, the 16-nozzle tank-side system was activated. During first test, operator also used an *Ansul 30B* hand-portable extinguisher for mop-up from ground level. Except for a persistent flicker on the paper insulation of one of the low side bushings, the piped system alone put out all the fire in only a fraction of the over-all extinguishing time. The hand extinguisher put out this flicker.

During a second test, the piped system alone completely extinguished a similar test fire. No reflash occurred.

In a third test, two trained men tried to extinguish a like fire from the ground. They used two *Ansul 150B* units simultaneously, but could not put the fire out. It continued to burn with its original intensity. When the piped system was then coupled in, fire was completely extinguished in 20 seconds. Two hand-portable extinguishers used from ground level, simultaneously with the discharge through the piped system, served as an extra precaution. But those present agreed that this added coverage was probably unnecessary.

COST COMPARISONS

One of the noteworthy factors of this new fire-protection system for large transformers is its very apparent low cost.

But it provides only a rather limited volume of extinguishing agent, may need ground assistance, and is not presently designed for automatic operation. Take care, therefore, not to misinterpret cost comparisons with conventional types of fully automatic systems. This is especially true when comparing with locations where water may be readily available in more or less unlimited supply.

Conservatively estimated, according to Weaver's report, the system can be installed on a transformer about the size of a 50,000-kva 132/66-kv unit, for about $600. This includes all pipe, fittings, nozzles and installation labor, but not the cost of wheeled dry-chemical units.

Even if you must buy two 350- and two 150-lb units, for initial and reserve discharge to the fixed-nozzle system and supplemental use from the ground, the complete installation for a single transformer would still cost less than half as much as a fully automatic deluge system. This is true even where adequate water supply is readily available.

For several transformers at one location, savings are even greater. And where adequate water supply is not readily available, this one-man 2-shot dry-chemical system can easily cost as little as one-tenth as much as a fully automatic deluge system.

CONCLUSIONS

From the test results, Weaver reached these conclusions:

1. One man can quickly and effectively extinguish a major transformer-insulating petroleum-oil fire on the cover of a tall transformer, if it is equipped with a properly designed tank-mounted fixed nozzle system to which he can manually connect a conventional wheeled dry-chemical fire extinguisher.

2. You must discharge an adequate quantity of dry chemical at a definite flow rate to extinguish effectively permanently. Discharge should continue after initial extinguishment to prevent reflash.

3. Occasional ground assistance may be required. Operator should use standard hand-portable or wheeled equipment simultaneously with the discharge through the fixed system.

4. If you meet the foregoing conditions, you don't need barriers to offset wind conditions, and you don't need water back-up to prevent reflash.

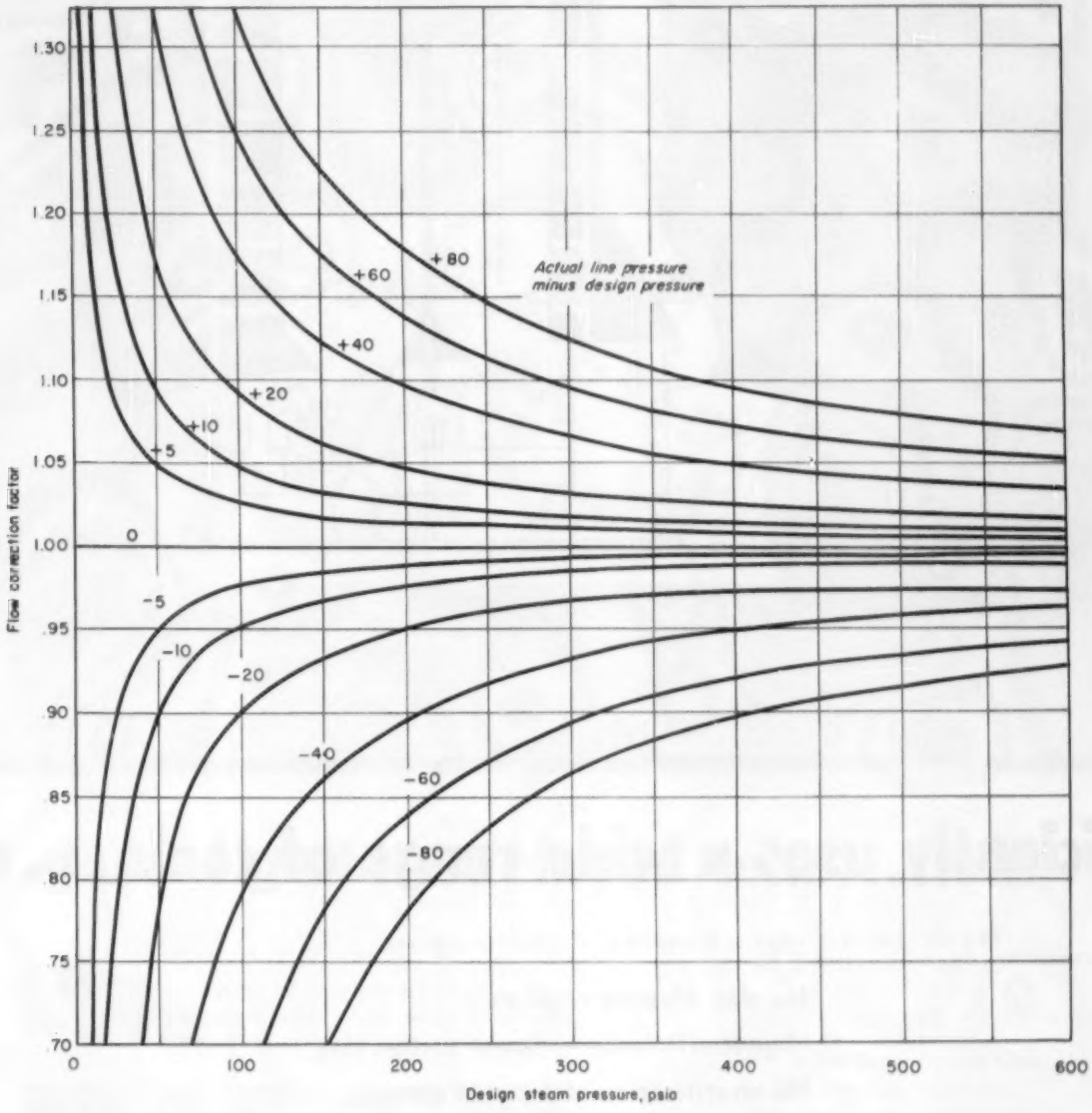
5. The number, type and location of nozzles, size of dry-chemical supply units, and size and arrangement of piping must be engineered for each specific transformer installation.

6. An automatic type of deluge system is more desirable at major attended locations and especially at major unattended locations, where size and service importance of the station justifies it. This is specially true if enough water is readily available or can be economically secured.

7. The tank-side mounted dry-chemical nozzle system offers a very effective and much cheaper alternative (depending on individual conditions) where (a) size and service importance of transformers justify definite fire protection but (b) barriers required for a conventional type automatic dry-chemical system are inadvisable or (c) water supply for an automatic deluge system is not available or is too costly.

Power's DATA SHEET

No. 282



Corrections for saturated-steam flowmeters

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Chart is based on the formula:

$$\text{Actual flow (lb/hr)} = \text{indicated flow (lb/hr)} \times \sqrt{V_1 \div V_2}$$

Where V_1 is specific volume of saturated steam at design pressure, and V_2 is specific volume of saturated steam at actual pressure.

Example: A saturated-steam orifice-type meter designed for 200 psia indicates a flow of 40,000 lb per hr. Actual line pressure is only 180 psia. Find the actual flow in lb per hr.

Solution: Actual minus design pressure = -20 psi
Flow correction factor (from curve) = .95
Actual flow = 40,000 × .95 = 38,000 lb per hr

SAMUEL A SEWALL, *Greenville, N. C.*

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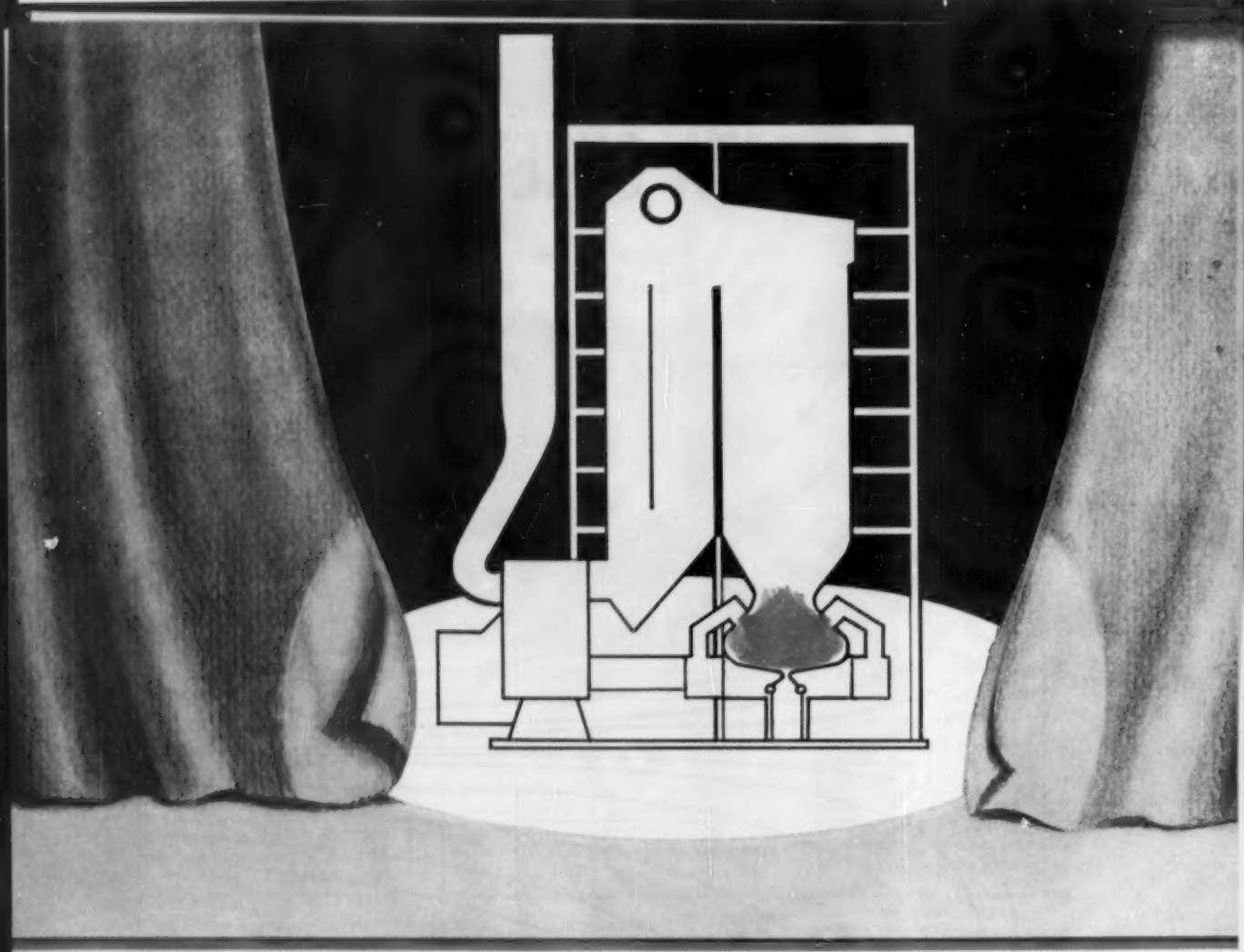

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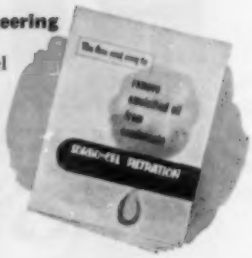

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STEVE ELONKA
Associate Editor in Charge

Dick Grant, plant engineer, tells us about . . .

Worker motivation and morale

'Give us training in human relations, not technical courses,' said 92 percent of the foremen in large industrial plants in a recent survey. Plant engineers need this training also

► AS A PLANT ENGINEER, my biggest problem in managing a maintenance organization is people, not technical details. We must have qualified men. There's no doubt that a good maintenance team needs sound policies and procedures. But, remember, regardless of how good people are, or how well plans are written, these factors alone won't mean a top maintenance crew.

We must *gain* work output from people. This isn't as tangible as many of our plant-engineering problems. We all have to follow certain well-defined basic ideas in our everyday work.

Men heading up a maintenance team usually have technical know-how. If the problem of synchronizing a 7-section production-line conveyor arises, we solve it. But when problem of synchronizing seven maintenance foremen faces us, we may stub our toe, grasp in the dark, and ask: "Why can't I get my men to pull together?"

Let's investigate ourselves. We have studied, trained and practiced overcom-

EDITOR'S NOTE: Fourth in a series. See "Selecting Plant Personnel," Dec 1954, pp 125-127; "Selecting Maintenance Men," June 1955, pp 117-119; "Aptitude Tests," Sept 1955, 107-109

DISCUSSION AND CONFIDENCE go hand in hand. Your department heads must have a voice in everything you plan to do

High morale gives workers a reason to extend

ing technical problems. We know our mechanical, civil, chemical and electrical engineering inside out. But there's one thing we may have missed—how well do we know our human engineering? Chances are not as well as we should, or we'd all have topnotch maintenance crews.

Let's dig into human engineering and see how to motivate our people. Let's see how to maintain high morale, which is so important.

Here's how I approach this problem in my own organization. In the past three years we have made two major changes. If these had not been handled properly, our department might have been in sad shape. One change was switching from centralized maintenance to modified-area maintenance. The other was dropping hourly-paid craft-group leaders who were in a bargaining unit. Now we have salaried foremen as craft supervisors.

Motivating people and keeping up their morale was a major problem in these changes. We didn't make them without ups and downs. But successful results show up in reduced maintenance costs, also in good relations with our people. Here are key points in human engineering that go along with changes of this type.

Step-by-step motivation. Motivation of people is no small job. Basically man objects to any change—largely because he isn't sure how he'll be affected. Besides, let's face the fact that our ideas in managing a maintenance group are worthless unless we can encourage men to accept our ideas and act upon them willingly. Putting through a major program one step at a time gives us the fullest chance to let each person know how it will affect him and his group.

To have a topnotch organization, we must always have a long-range program, moving one step at a time toward its goal. To start each step, we need group acceptance of a plan. So we direct motivation efforts at the group. We explain how a plan will benefit the group. If we direct motivation at individuals, workers tend to deviate from the group. Then we may run into strong individual resistance. Remember, an organization works as a group, and, therefore, must be motivated as a group.

A well-planned program can move forward through each step without upsetting department's morale. Too many try to do it all at once. Then nothing succeeds, there's no progress. Importance of getting workers' OK cannot be stressed too much. Workers must believe in what they are doing to be happy on the job. Satisfaction, in turn, helps us get high-level work from our department.

Discussion, confidence. One of the easiest ways to motivate people is through discussion before action. If we take time to discuss a change, people feel they have a part in the decision. Then they work twice as hard in putting it over. Through discussion, they know how they as a group and as individuals will be affected. We all like to have a voice in our affairs. If it's a supervisory change—talk with supervisors. If it's a union matter—talk with union representatives. Even if people consulted play no part in a decision, they accept change in a different frame of mind if we consult them.

I believe motivation of craftsmen differs from that of production workers. A craftsman prides himself on knowing how to do his job. So he resents a foreman telling him in detail how to do it. To get work output, a foreman must show confidence in craftsmen by assigning a job and leaving details to each man. He shouldn't breathe down a mechanic's neck to see that he's doing his work right. This is especially true with higher-skilled crafts. To achieve satisfaction in their work, skilled craftsmen desire chance for decision, judgment.

With qualified craftsmen, we get greater work output by showing confidence. This one factor can mean the difference between an excellent and an average workman: Difference between one satisfied in his job and one whose dissatisfaction shows in less work, lower-quality workmanship.

Attitude, morale, work output of crew is a reflection of supervisor's attitude. This follows right down to newest mechanic. Don't expect a craftsman to be enthusiastic unless his foreman is. So—start with yourself in building morale.

First, approach all problems with sincerity, fairness and a friendly state of mind. If you find your department's morale low, start with supervisors. Develop an enthusiastic, hard-hitting team. Supervisors are leaders and must act as such. Always look to your foremen as administrators of work and not grease

BE FRIENDLY with your maintenance people, get to know each by his first name

their efforts and gain promotion

monkeys. While I've used the foreman as an example, the same rule applies in all levels of supervision. These men set the pattern for the group, but the pattern must be right. So keep your supervisors aware of your departments and operating results.

Supervisory-training sessions. Important point in keeping up morale is to pass all possible information to the people responsible for work. When aims and goals are set, a supervisor wants to know how he's doing.

To hold morale and motivate our programs, I hold a supervisory training meeting once a month. Goal is "reduced maintenance cost with increased workmanship quality."

We have ten maintenance yardsticks for guidance and trend indicators. In December, our goals for the coming year are established, based on realistic plans for improvement. Some goals are in man-hour figures that foremen and supervisors easily understand. Others are in dollar figures used by higher management. Idea is to make supervisors and foremen aware of dollars involved. All goals predict our maintenance cost for coming year.

Each month during the year, we show past month's results to supervisors and foremen. These are compared with our goals. Unusual maintenance items for coming month are noted. At each session we use one yardstick of measurement as topic for a group discussion. Discussion is about how we, as supervisors, can do an improved job. Encourage group discussion on what to do for improvement. That develops everyone's effort and supervisors feel they're a part of team. This is important.

Reason why. Easiest way to destroy morale is to keep your aims to yourself. That happens when the man doing a job doesn't know what he's supposed to accomplish. You can't expect a person to have high morale if he has no idea how his work is to affect the endpoint in operation. It takes only a second to explain the importance of any job. Always give as many reasons as possible. With a reason why, men attack problems with a new attitude.

Employe activities. Your firm's policies on employe activities affect your people's morale. You, as department head, can capitalize on worker benefits by actively taking part and by believing wholeheartedly in your firm's programs for benefits. Many such activities give you a chance for friendly talks with the worker and his family. This is a big morale builder.

Policy development. Policies of your maintenance department have a marked effect on morale. When developing policies on human relations, always have the worker's morale in mind. I've found these points to be basic: (1) be consistent (2) answer every question (3) handle personnel matters promptly. Above all, be fair. Follow religiously the policies you outline.

Talk with your people. As plant engineer, you cannot run your department from a swivel chair. First, you must spend time around your power services and production machines. That gives you first-hand opinions of the work your people do. Your presence and interest also give your departments a sense of security.

Secondly, take time to associate with foremen and craftsmen. Fact that you talk with a machinist, welder or foreman gives him a sense of belonging. Remember, you're the big boss to him. Talking and calling him by his first name means you recognize him.

A friendly, sympathetic supervisor can draw more work from his people than one who is cold and aloof. Workers desire recognition. So tell them when they do a good job. Also, correct them when they make mistakes. Supervisor can be friendly and still remain firm, when necessary.

Housekeeping. Working conditions have a direct reflection on morale. This means a neat plant. Poor housekeeping means poor working conditions, poor quality of workmanship and poor morale. This item is a MUST for each individual to observe every day. It's also a habit, so make it a *good* habit. Nobody likes to work in a dirty area.

Promote from within. Maintaining high morale comes from promotion from within. It gives a worker a goal, a reason to extend himself, to make that extra effort which may lead to promotion. But this isn't always possible. If a qualified person isn't available, don't promote from within just to be a "good Joe." New blood often improves morale. But selection must be good and workers must see that you have provided them with a good supervisor.

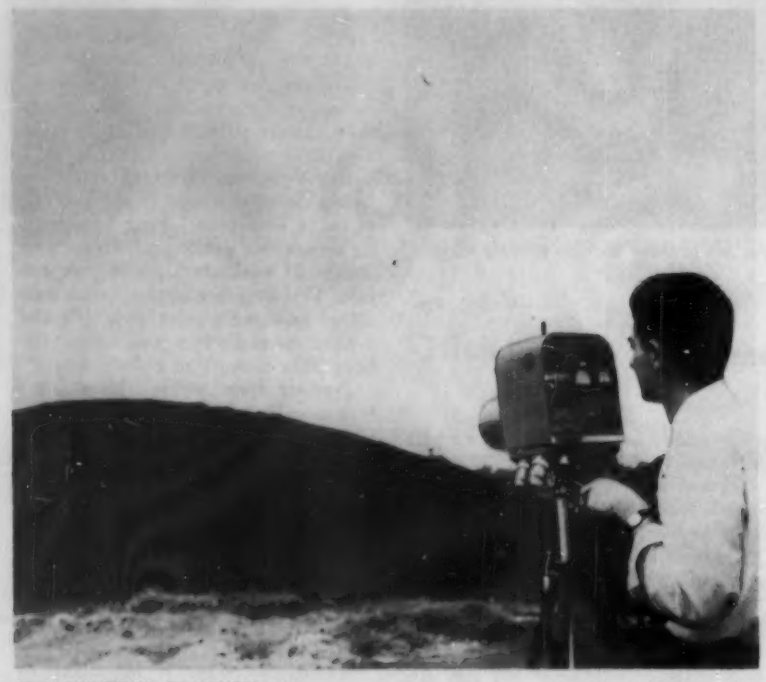
Making decisions is important to morale. Don't be vague. Your decisions are vital to your men. A vague answer without a decision gives a worker a sense of insecurity. He probably says: "Boss doesn't know what he wants to do, what in hell am I supposed to do?" Give your men a decision and pick the road for all to travel.

Be your own personnel man, but be a good one. Motivation and morale of your workers cannot be left to personnel department. YOU are the man to gain or lose, YOU are the man to fail or succeed. This depends on your ability to get best work out of your people. Your technical engineering may be tops, but your human engineering must be there too. You have to be able to get along with your fellow men. Be sincere and fair. There's no greater challenge to engineers today than human engineering. Accept that challenge, attack it with vigor and stamina. Then you will find your department running at reduced costs, with high morale.

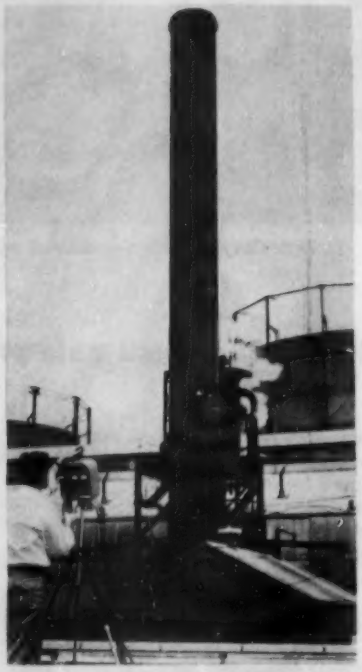
Based on talk by Dick Grant, 6th Plant Maintenance & Engineering Conference, Chicago, Ill., Jan 1955. Grant is plant engineer, Owens-Corning Fiberglas Corp, Kansas City, Mo.

OPERATORS' NOTEBOOK 92

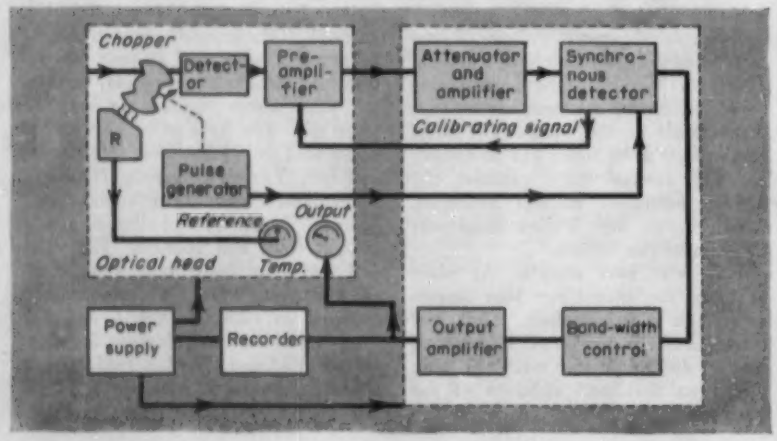
Now you can measure heat



SPONTANEOUS COMBUSTION in a coal pile can be kept in check with this radiometer. By scanning the pile, you can spot presence of hot spots at an early stage. Then by simple triangulation, the location of hot spot can be pinpointed, far sooner than is otherwise possible. Such fires are a common hazard and can be costly. They are usually extinguished by dragging tons of coal off the pile's top, or by smothering. Instrument is also handy for finding hot spots in furnaces, calcining drums, machinery, refinery equipment, and it has many other uses around most industrial plants



STACK RADIATION registers on device, tells hot spots of refractory lining, finds thin spots before ceramic stack (metal here) can fail. Optical filters on the adjustable slide eliminate unwanted visible radiation, narrow the band to just radiation coming off stack to give you the info



How radiometer works

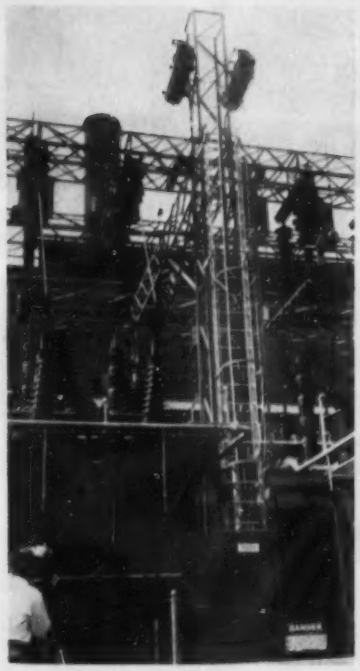
► RADIOMETER measures infrared radiation given off by a body. This amount of radiation is directly related to the body's temperature. Instrument has no contact with object being measured—it can be hundreds of feet away.

Instrument is so sensitive it measures temperature of bearings on fast-moving railroad cars as they whiz by. Most useful for temperatures up to 500 C.

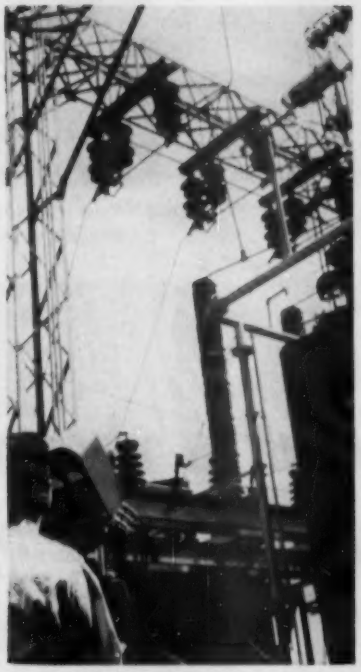
To use, focus optical system of radiometer on object. Radiation is focused on ultrasensitive detector in the instrument. Detector is fitted with a tiny thermistor flake whose conductivity

quickly — at a safe distance

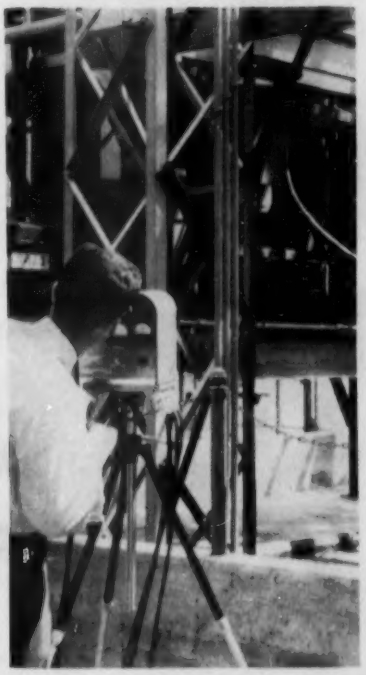
By STEVE ELONKA
Associate Editor



TRANSFORMER - INSULATOR checking tells exact temperature. Insulators may become hot from leakage, or for other reason. These can all be quickly scanned in this substation. Because of high voltages, your conventional thermocouples cannot be used in applications like this



INSULATOR AND JOINT temperatures on this mechanical cutout are known from ground—at safe distance. Only other way to do job is to shut off power. Then down-time enters picture. Use device also in areas of high radioactivity where you must be distance away for safety



JUNCTION POINT of three cables forming single underground cable may overheat, cause cable failure. Also, check temperature rise in all parts of overhead system, like flues, transmission lines, conduits. Radiometer is especially good if temperature is below that of red heat

. . . and some of its uses

changes with temperature. Then when radiation strikes flake, it heats up and change in conductivity of this flake is amplified and measured in electronic circuitry.

Electronic system. Incoming radiation falls upon the detector, see diagram. The detector converts the radiant energy into pulses. These pulses are fed to the input of the preamplifier. This is an ac amplifier, does away with dc systems' instability, drift problems.

Output signal of preamplifier has sufficient amplitude to operate the following amplifier through 100 feet of cable. And there's neither noise nor pickup problems.

Second amplifier either increases or thins the applied signal so it maintains proper signal level at synchronous detector. This detector is locked in step with the chopper through pulse generator. This unit reconverts signal to dc. The signal is now sent through the band-width control, settable from dc to 0.1, 1.0 and 10 cycles per second.

Unit permits operator to select optimum system constants for a specific measurement. By selecting minimum band width, the system yields maximum sensitivity with increased response time. Or by selecting maximum band width, system yields minimum response time and decreased sensitivity.

A cathode-follower output stage furnishes a signal suitable for operating the Sanborn or Brush type recorders through cables. For operator's convenience, meter on the optical head measures the recorder output. A regular power supply produces needed voltages to operate system. Radiometer has a well-shielded low-noise thermistor-bolometer detector-bias voltage source. *Courtesy, Barnes Engineering Co*

1 Run a 3/8 in. wide × 3/16 in. high × 3/4 in. long welding bead along the tube, of the same alloy as the tube metal

By M A LADT
Carbide and Carbon Chemicals Co
Texas City, Texas

Let's install a thermocouple to measure tube temperature

In collecting boiler performance data, Carbide and Carbon used several types of thermocouple installations. Here's the one they find works best. Bonus feature: It's a low-cost method

► BEFORE GOING AHEAD with any thermocouple installation in boilers make sure you've given careful attention to its location—side or bottom of the tube, or shielded from radiation and convection heat input.

First step. Choose a welding rod of the same alloy as the tube metal and lay down a bead about 3/8 in. wide × 3/16. high × 3/4 in. long. Cut a transverse slot across the bead with a hack saw. But make sure that the saw cut doesn't penetrate the tube metal itself. Cut the slot just wide enough to fit the thermocouple wires. We've found that 20-gage wire chromel-alumel thermocouples do a top job. And some of our installations operate for long periods of time inside the boiler setting.

Next, twist and tin the thermocouple pair and lay it in the slot. To get a metal-to-metal connection, flow the weld metal over the thermocouple with a diamond-point chisel or snub-nozed punch. Peening insures solid contact between the thermocouple and the weld metal.

Now, cover the thermocouple with a section of preformed insulation—its length about three times the tube diameter. Tying two halves of the preformed insulation together with stainless-steel wire keeps it in position.

To bring wires out to the instrument, run the thermocouple through the setting wall wherever a pipe coupling or other opening is available. And make sure to support the thermocouple wire inside the setting to keep it out of the way. Asbestos tape does a good job as supporting material for the couple.

This arrangement isn't permanent. But even in high-temperature zones it lasts long enough to yield a wealth of performance data. It's not expensive either.

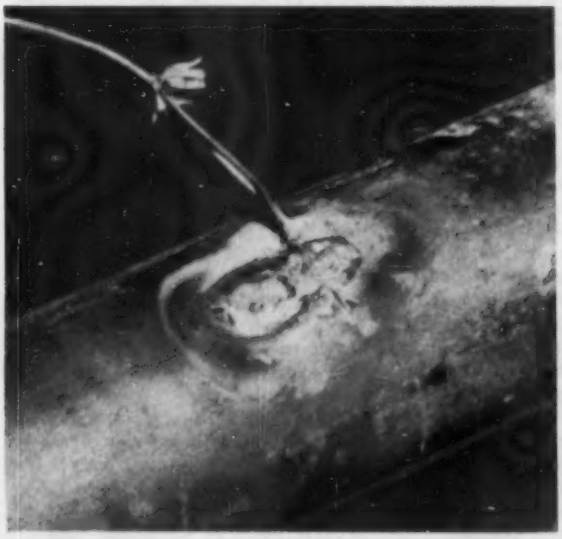
Spot measurements vs averages. We prefer to take readings at various points—as fast as we can read them. For instance, we might take 10 temperatures across a superheater bank at 5-minute intervals, for two hours. By plotting temperature vs time for each set of readings we get a characteristic curve for the particular operating condition. Once we've monitored a series of operating conditions in this way, we'll make occasional spot checks of one or two temperatures to give us an idea of conditions in the setting.

2 Welding bead must be on side or bottom of the tube or shielded from convection and radiation from furnace heat, in order to measure the true tube temperature

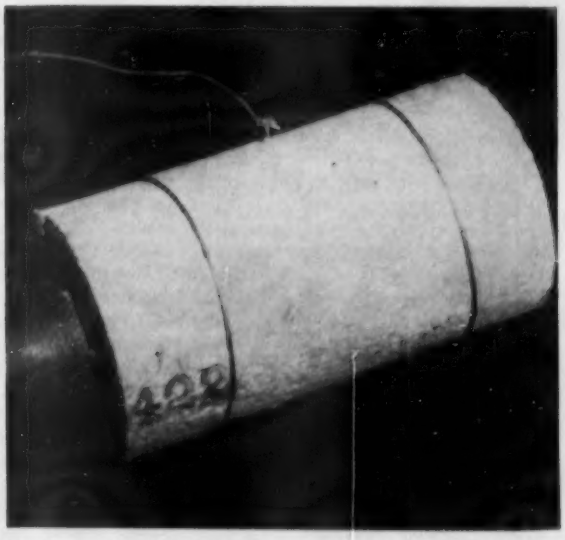
3 Cut a slot across the bead with a hack saw, to hold the thermocouple

4 Make sure that saw cut doesn't penetrate the tube metal itself. Then, twist and tin the thermocouple pair and carefully position it in the slot cut out for wires

5 Flow weld metal over thermocouple with a chisel or snub-nosed punch



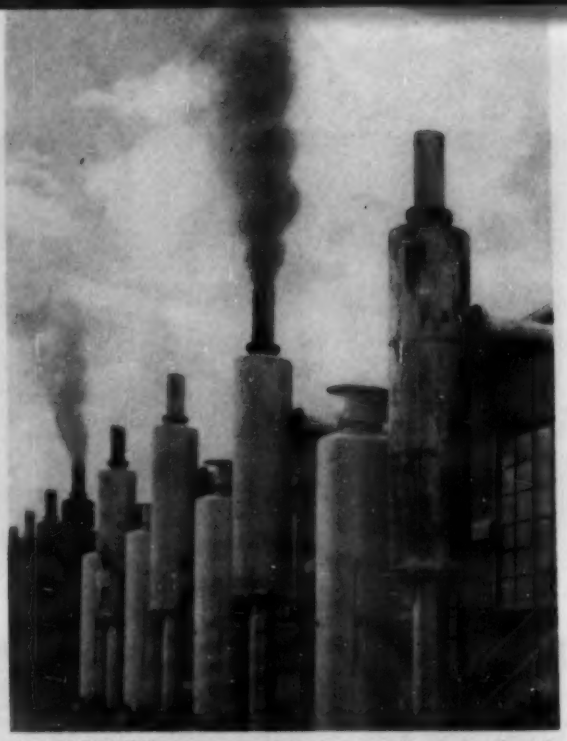
6 Peen over the weld to insure good contact between the thermocouple wires and the weld metal, before insulating



7 Cover the thermocouple with a section of preformed insulation, about three times the tube diameter, in length

You can stop diesel smoke

By PAUL D HOBSON, *State College, Pa*

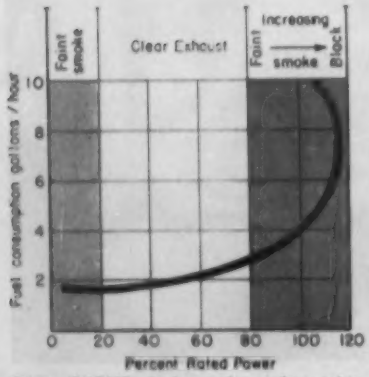


DIRTY EXHAUST means expensive fuel is going up stack while engine valves and piston rings are being coated with carbon

► ALL DIESELS smoke some of the time, some diesels all the time. The basic causes and the effects of smoke on an engine are not always understood, but soot can be very harmful.

Did you know that soot formed in standard open-chamber engine on overload has been used as a substitute for alumina lapping powder? It is hard enough to scratch 600-Brinell hardened steel. Soot formed by other fuels and in other engine types may not be as good an abrasive, but it still isn't good for your engine.

Smoke causes. Final cause of diesel smoke is always the same—incomplete combustion. If there isn't enough air in the cylinder to burn all fuel injected before exhaust opens, as in an overloaded engine, black or "hot" smoke is formed. If fuel is ignited late or not at all, gray-white "cold" smoke appears. This is from droplets of unburned fuel in the exhaust.



FUEL CURVE and smoke relationship, as shown here, are for a normal engine

If lubricating oil is passing by the piston and is not burned in combustion space, smoke will be bluish-white. This type of smoke is normally from worn cylinders or defective rings. I won't talk about it here.

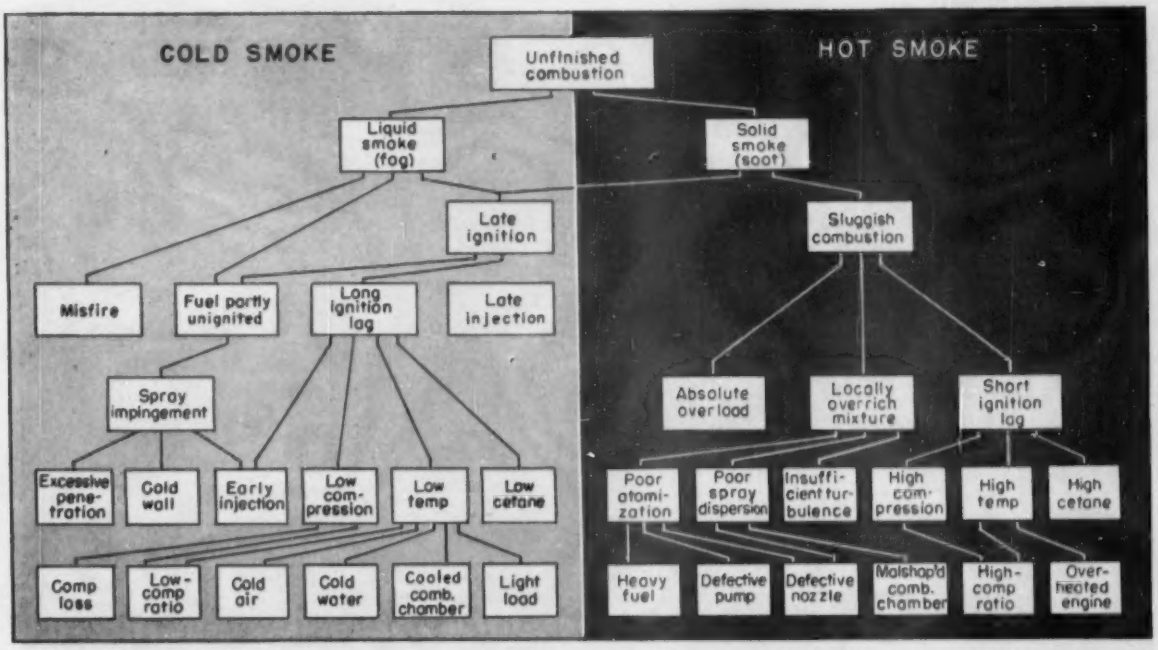
Don't forget that a badly balanced fuel pump is certain to cause smoke in a multicylinder engine. If engine is running at or near its full load, cylinders getting too much fuel will be overloaded. Then at light load the other cylinders may misfire.

Hot smoke consists of soot particles due mostly to sluggish combustion. This, in turn, is usually from an over-rich fuel mixture. Theoretically 14.5 pounds of air are needed to burn one pound of fuel. But air-fuel mixture isn't uniformly distributed in diesel combustion space as in a gasoline engine. So about 20 pounds of air are needed in practice to avoid local over-rich mixture during combustion. This assumes a well-designed engine in good condition. If spray distribution or air turbulence is inadequate or disturbed, you can have local oxygen deficiency with a very lean over-all air-fuel ratio.

Fact is, under these circumstances hot smoke and cold smoke may be produced in different parts of same cylinder. In a standard solid-injection diesel, everything that improves air-fuel mixture reduces hot smoke. And anything like poor atomization, poor spray distribution or lack of air turbulence that hinders mixture will tend to make your engine smoke.

One cause of smoke, not always recognized, is too short an ignition delay. You may have hot smoke if fuel ignites too soon after injection, which may occur if engine temperature or compression is too high, or if fuel has too high a cetane number (more than 65 for most engines). Reason for this is not completely understood. Probable answer is that fuel ignites before the spray has been able to move more than a very short distance from injector. Rest of fuel ignites as it enters the flame front, and the air in that part of the combustion chamber more remote from the nozzle is unable to take part in the combustion. These causes of smoke may be seen on right-hand side of chart, facing page (reading up from the bottom). Professor P H Schweitzer, Penn State University, prepared this chart.

Other cause of hot smoke, and the commonest, is overload. Curve, at the left, shows a plot of fuel consumption



COLD SMOKE is caused by entirely different conditions from those producing hot smoke. Study the chart carefully, keep it for reference. This breakdown, one of the most valuable we have seen, should help you nail down your smoking problems

in gallons per hour against percent rated horsepower at constant speed for a typical stationary diesel. You can see that a power increase of about 15% over rated full-load power is available if black exhaust smoke is acceptable. But your fuel consumption curve rises almost vertically at this load without further power increase. After that the power available actually falls off with increased fuel delivery.

Effects. Most obvious effect of operation with hot-smoke formation, apart from exhaust fumes themselves, is an increase in combustion chamber deposits. This may lead to stuck rings and valves. Less immediately obvious effect, but serious, is contaminating lube oil with fuel-soot particles. Fuel soot consists mostly of carbon particles. But trouble is these are more like crushed coke than colloidal graphite. Hardness and abrasive quality of particles tend to increase with sulfur and ash contents of fuel. So if you can't help running with a smoking exhaust, use a No. 1-D fuel to avoid heavy liner wear. Many cases of high cylinder wear with high sulfur fuel are due to this formation of abrasive soot in cylinder rather than to effects of acid formation.

With a constant-speed engine, you can set fuel rack so too much fuel can't be delivered. But if you do this with a variable-speed engine so exhaust is clear at full load and speed, engine won't deliver full torque at lower speeds. Reason is that delivery of standard Bosch-type fuel pump falls off with speed at a constant rack setting.

Relatively complicated speed or vacuum-operated controls are on market to solve this trouble. But you may try using a spill-valve type fuel pump. This delivers more fuel as the speed falls off, thus increasing engine lugging capacity.

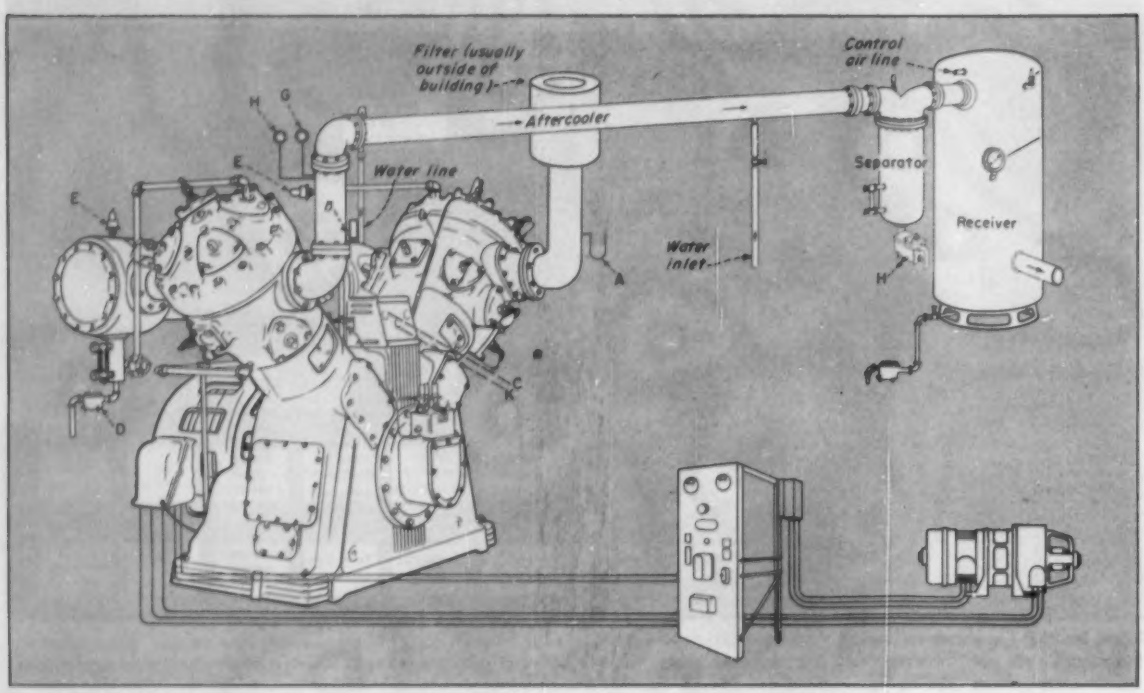
Cold smoke is from late ignition. In extreme case of complete misfire the ignition never occurs. Then droplets of fuel pass into exhaust. At times, some of the fuel injected will ignite and some won't. Then unignited portion passes out as droplets as before; remainder may burn clean or may even produce hot smoke from lack of oxygen. At other times, fuel may all ignite, but so late in stroke that burning is still going on when exhaust opens. Smoke so produced is mostly composed of cracked and half-burned fuel particles. This smoke is darker than that due to ignition failure. But you can tell it from regular hot smoke by test described later and by strong, unpleasant smell.

Consider causes of misfire with those of late ignition. Reason is that any condition producing late ignition will, if carried to extreme, cause complete misfire. Late ignition may be simply from late injection timing. If so, it's easily corrected. It may also be from overlong ignition delay due, in turn, to low combustion-chamber temperature or pressure, very low cetane-number fuel or too *early* injection. This last may cause ignition lag from fuel injected into air that's too cold to ignite. Then by time air is hot enough, spray has broken up so fuel ignites late or not at all.

Partial ignition is usually from defective injection equipment. If part of fuel spray doesn't atomize, or impinges on a cold surface in combustion space, it probably won't burn, even if remainder does. You might also have partial ignition from overlong ignition delay, especially if injection has advanced too much. Interrelation of these various causes of cold smoke is shown on left side of chart, above. Water in fuel may also cause partial ignition or complete misfire. Cold smoke won't usually do much harm to engine, except by washing the oil film off upper cylinder wall and by general fuel dilution of lube oil. Sometimes it causes fuel varnish and other deposits around piston rings. Cold smoke always means fuel waste. Then, again, odor given off doesn't help your firm's public relations.

Remedy for cold smoke is usually to correct the timing and condition of injection system. If this isn't enough, advancing the ignition timing a little may help. But this must be done without causing rough running. Excessive

(*Continued on page* 196)



RECOMMENDED ACCESSORIES and protective devices for a typical modern compressed-air system serving an industrial load. Some units shown are optional. See text for a discussion of the purpose and use of each of these accessories and devices

Right distribution piping means better output, fewer losses in compressed-air systems

By H H MILLER, *Consultant*
Compressed Air and Gas Institute

► LAST MONTH, pp 118-119, we gave a number of items you must consider when choosing air compressors for industrial jobs. Now we're ready to take a look at air distribution.

This system is the piping between the compressor and air tools, and the other units. It usually includes a number of devices besides the piping, as the illustration above shows. Excessive pressure losses in the piping are like money dropped down the drain—you can't get it back. Low pressure at the tools means they do less work because their speed is lower and they take a weaker bite on the work.

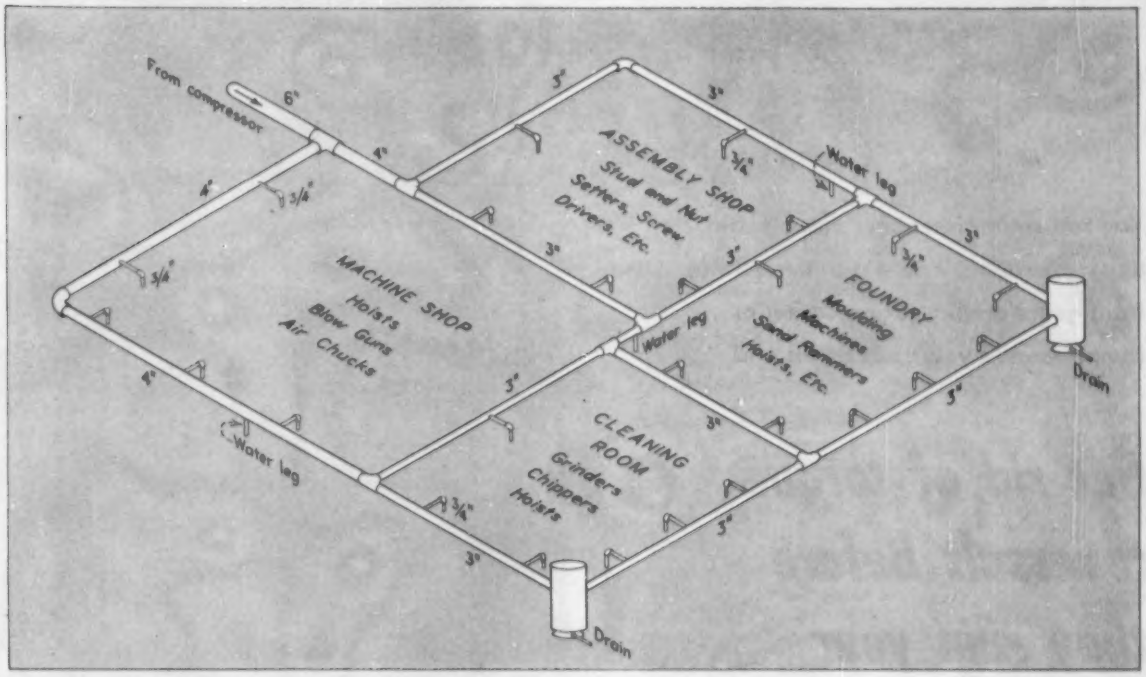
Size and arrangement of piping should be given as much thought as the compressor installation. Oversize or large piping is a good investment, especially if the plant will need more air in the future. Large piping adds little to the first cost of a plant because the labor cost for pipe installation is about the same and difference in pipe cost is not a large item. Undersize piping is a constant daily loss. Fixing it takes a major outlay.

Pressure drop between compressor and most distant point in the system shouldn't be more than 5 psi at normal flow. If possible, use a loop system, facing page, because this allows the air to flow in two directions. Scheme shown is only a suggestion—plant size, air needs, etc, may change system details.

Size of discharge pipe between compressor and receiver is the same as the compressor outlet because this pipe transmits a pulsating flow. Size can be slightly reduced beyond the receiver because pulsations in it are eliminated. Often the pipe divides to supply various parts of the plant. Or, where there is a major takeoff, the pipe is again reduced in size. Number of ¾-in. takeoffs to various tools, facing page, is only a suggestion. Some sides of the building may need more than shown.

Takeoffs are usually fitted with a tee—two or more air hoses being attached to a single 1-in. takeoff. Locate it so the air hose is as short as possible since hose friction is great. Connect takeoff to top of main—this cuts amount of moisture entering hose. Water legs, connected to bottom of main, provide for condensate drainage at strategic intervals. Legs in 6- or 8-in. mains can be one foot long.

Slope air lines toward tools, and away from compressor, so moisture drains through legs. It's a good idea to put reasonable-sized receivers at the most distant points from the compressor. These help equalize pressures, take care of instantaneous demands and aid in ridding the lines of water.



LOOP DISTRIBUTION SYSTEM, typical for an industrial-plant compressed-air installation. Pipe size and arrangement will vary with the type of plant, system capacity, tools employed, work load, etc. Sizing procedure for loop is given in text

In heated buildings, use automatic moisture traps for the receivers and water legs. Use manual drains for units in cold areas—this prevents the danger of a trap freezing.

In system above, compressor capacity is 1000 cfm. Loss through each 4-in. line, which is 1000 ft long, is found from a handbook to be 0.55 psi for 500-cfm flow. Assume 60% of the air flows through the 3-in. line. Friction loss for 300 cfm in 1000 ft of pipe is 0.84 psi. During passage through a ¾-in. takeoff with its elbows, valves and couplings, there is a 1-psi assumed loss. Hose length is probably less than 50 ft and average air flow is 60 cfm. Friction loss in hose is 1.6 psi, to give 90 psi at tool.

Now find total friction loss to most distant point by adding up the various losses listed above. This gives a total of 4 psi, a conservative drop.

If the air lines were only 500 ft long, the next smaller pipe size might be suitable for each run. Using a ¾-in. takeoff again, you figure the total loss as 5.11 psi. If a 3-in. line were used throughout, instead of reducing to 2½ in., a saving in pipe friction would be a little less than 1 psi. Saving for the smaller pipe would not be much and there would be little reserve for the future.

Intake piping. Size the short intakes the same as compressor inlet, but check with manufacturer. Velocity in intake pipe should be not more than 2500 ft per min. If intake pipe is 20 ft long, increase its size by 2 in.; if 40 ft long, increase its size another 2 in. Use an air filter on intake.

Be sure all piping is carefully supported. Pipe between compressor and receiver is subjected to pulsations that can lead to vibration.

Compressor location is important, and experience shows that having the compressor in the power plant, or near it, pays off because the area is usually clean and ready supervision is available. But if a long pipe run between the compressor and tools is needed, it may be better to put the compressor near the tools, tying its piping into the main. Compressor should be in power plant, if possible.

Where a central location is not possible, two units may be used, one near each of the areas to be served. In some plants, small compressors are spotted throughout the production areas, supplying nearby tools.

Motor-driven compressors outnumber all other types by more than 6 to 1. Synchronous motors are most commonly used. Before choosing a compressor motor, check the starting current and torque, power factor, flywheel effect, etc.

Unity-power-factor motors are the most common, but where a leading power-factor motor will help, an 80% unit is generally installed. This is an easy way to boost plant power factor.

Steam, gas and diesel engines are also used for compressor drive. They often prove economical where they aid the plant heat balance, or fuel is readily available.

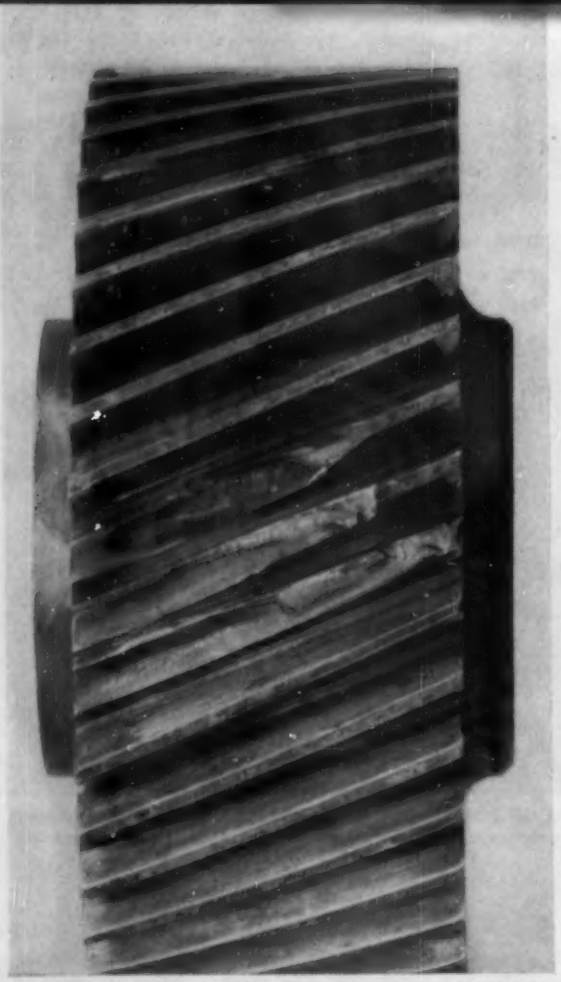
Protective devices and accessories are shown in the installation, facing page. Vacuum gage *A* aids in checking filter cleanliness. Thermometer *B* helps spot leaky valves and pistons in compressor. Pressure gage on intercooler *C* is standard. Fit intercooler with an automatic moisture trap *D* and a safety valve *E*. Safety valve should also be fitted to receiver and discharge piping, ahead of any stop valve.

High-pressure cylinder thermometer *F* has same use as *B*. Overpressure shutdown *G* should always be used when unit runs without an attendant. Aftercooler trap *H* is automatic type. Pressure gage on receiver *I* should conform to *ASME Code*. Automatic trap *J* is used in heated buildings. Fit an oil-pressure gage *K* for compressor bearings when a pressure lube system is used. A thermometer *L* may be fitted to compressor lube system, if desired. It is good insurance.

You can cut maintenance costs, avoid noisy operation, and get better service from gears driving reciprocating air compressors if you track down and

Get rid of torque reversals before they ruin your high-speed gears

By D G KIRK, *Lynn River Works, General Electric Company*



TORQUE REVERSALS amplified by resonance in the installation caused severe pitting and broken teeth in this test gear

► A RECIPROCATING air compressor always has cyclic torque variations.

If torque reversals are transmitted to the gear connecting compressor with prime mover, you get noisy operation, no matter how accurately gear was manufactured. The teeth ultimately wear, damaging tooth profile. Unit runs roughly; in severe cases, teeth may fail.

Even without torque reversals, the gear may be subjected to high peak loads that cause irregular wear. Such tooth wear becomes self-propagating and tends to accelerate rapidly once a definite pattern is established.

Misapplication troubles. A misapplication of a reduction gear unit with a reciprocating compressor can cause no end of trouble to both user and gear manufacturer. The gear, being sensitive to shock loading, may rapidly become noisy and fail in service.

For the user, this results in excessive maintenance costs, employe dissatisfaction because of a noisy work area, and undependable service.

For the gear manufacturer, it creates dissatisfied customers, bad publicity, a lack of confidence in gears in general and a feeling among prospective users that the turbine gear unit in particular represents a bad application when used with reciprocating machinery.

Fortunately, you can find out whether there will be harmful oscillatory torques. A torsional analysis of the system, made by gear manufacturer or any qualified engineer, gives you the answer. This is particularly valuable if gear was originally designed for a nonreciprocating application.

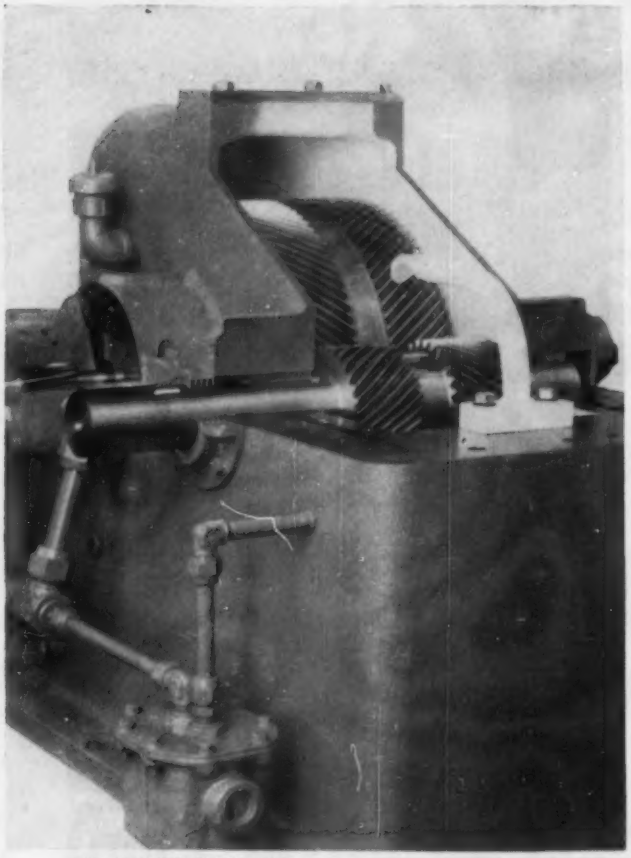
For example, let's take a reciprocating air-compressor installation (upper right sketch, facing page). It includes a single-reduction gear unit originally designed and used for a steady-state operation. The installation did not receive the benefit of a torsional analysis. Gear was fully capable of carrying the steady-state full-load torque, but it wore excessively. So installation was noisy and generally unsatisfactory.

We were called in, asked to study the situation and make recommendations. The maintenance record showed that one pinion bearing was replaced after only a year's operation. Later, gear was excessively noisy; all bearings were badly worn and needed replacement. Pinion teeth also showed signs of wear. Bearings were replaced with a new set and unit put back into service.

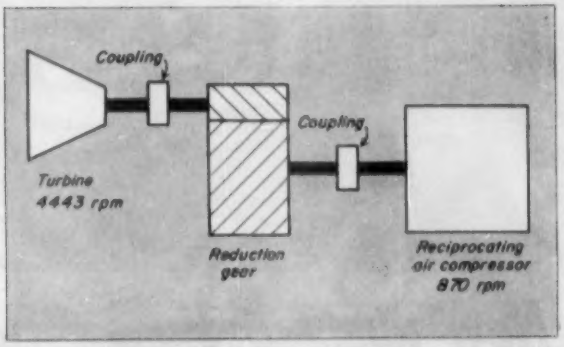
But this repair was only temporary. In a short while the gear again became noisy, rough running and in need of reconditioning.

We found that at no-load conditions the unit performed smoothly and quietly at the governed speed. But under load, gear clatter was very noticeable. Frequency of the gear-mesh disturbance corresponded exactly with compressor speed.

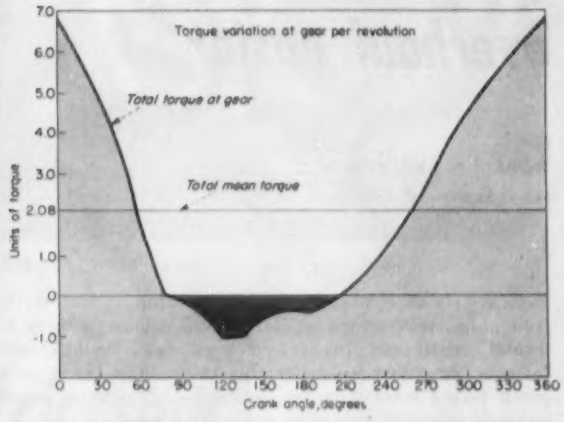
Our on-the-spot analysis was that gear experienced a torque reversal causing pinion and gear teeth to separate momentarily. The clatter occurred every time teeth came back into contact.



SPEED REDUCING GEAR, typical for service with reciprocating equipment. The unit has its own independent lubricating system



REDUCTION GEAR gave unsatisfactory service until we found torque reversals and made changes in the type of coupling



TOTAL TORQUE at gear varied once per revolution from a maximum of 330% of total mean torque to minimum of −50%

Technical analysis. Here's a more detailed analysis: Where machinery is made up of two or more rotating masses coupled together by relatively flexible shafting, the rotating system has natural torsional vibration characteristics that make it respond to torque impulses. Degree of response depends on how close frequency of the impulse is to the natural frequency, or some harmonic of the natural frequency, of the particular mass elastic system. Where torque-impulse frequency is close to a natural frequency or a harmonic, a small pulsation in the system can be greatly amplified at the gear.

This particular installation was subjected to a torque impulse sent out at the frequency of one impulse per compressor revolution.

Using compressor torque characteristics obtained from the manufacturer, analyzing the entire system for torque amplification, and applying the amplification factors to their respective harmonics permitted us to plot a curve showing how torque at the gear varied per revolution (curve, above at right).

The analysis showed that torque varied from a maximum of 330% of total mean torque to a minimum of minus 50%. The torque reversal at once per revolution substantiated the observation made during our visit to the plant.

Changes. To change response of compressor oscillatory torque at the gear, we had to reduce the torque amplification. This could be done by (1) adding a flywheel to the reciprocating unit to increase its inertia and (2) changing the type of couplings between compressor and gear, or between pinion and turbine, thus changing shafting's torsional flexibility.

We decided to replace the torsionally rigid gear-type coupling between compressor and reduction gear with a torsionally flexible coupling. The coupling selected also had an appreciable amount of inertia, so it could act as a flywheel.

We calculated that the added inertia and increased flexibility between compressor and reduction gear would reduce the vibratory torque enough to eliminate torque reversals completely, and also substantially reduce the peak torque.

Since the recommended coupling has been installed, unit runs smoothly and quietly. It is entirely satisfactory to the user.

Keeping out of trouble. This user had a completely unsatisfactory installation. It required excessive maintenance dollars, caused employe dissatisfaction, and gave an unreliable source of compressed air. The cost in replacement parts, labor and loss of use is estimated as greater than the original cost of the gear.

Yet torsional analysis would have suggested proper revisions for a trouble-free unit. Similar analysis on any machine subject to torque impulses will also guard against coupling troubles, shaft fatigue and rough operation.

New pump designs make inspection and overhaul easier

By PAUL H J KALVELAGE
Design Engineer, Goulds Pumps, Inc

► CENTRIFUGAL PUMPS designed for handling paper stock, fruit pulps, mashes and similar materials must be easy to inspect, repair and overhaul. For example, in the paper industry, downtime is usually only two to four hours, so a pump taking more time for overhaul or inspection could seriously interfere with plant output.

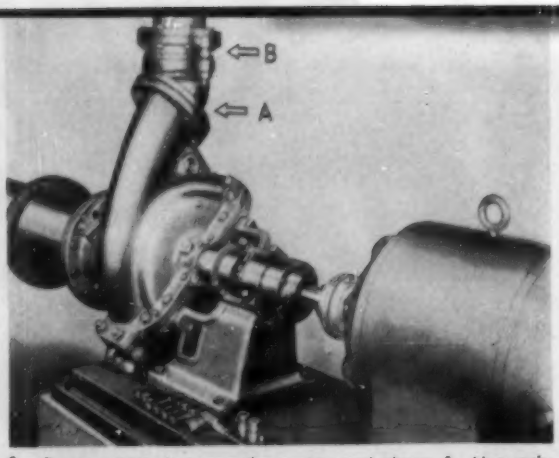
Diagonally split casing-type pump, *right*, is a design especially developed for quick, easy overhaul. Its hinged-cover casing has jacking bolts to save time and effort when upper half of pump is removed to check or replace the rotating element.

Start pump disassembly by removing bolts connecting the discharge elbow and upper half of casing, *A*, Fig. 1. Telescope discharge elbow into discharge connection, using jacking arrangement, *B*. This gives working clearance without damaging the gasket.

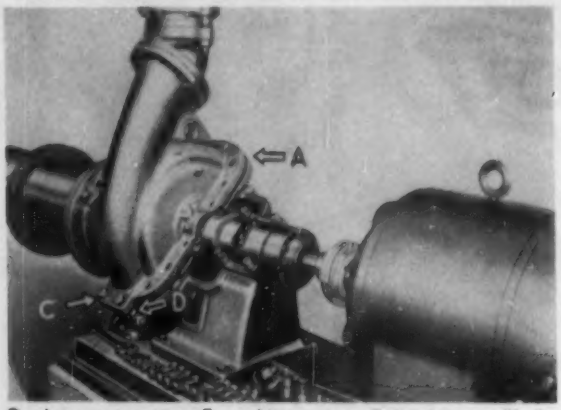
Next, remove parting bolts connecting upper and lower halves of pump casing. Loosen top nuts, *C* Fig. 2, of the hinge pins. Raise casing off sideplate locks by tightening hex nuts *D* below upper flange. Use jack screw *A* to raise the other edge of the upper half of the casing.

Attach chain fall through hole provided in upper half of casing, Fig. 3. Continue to raise casing by jack screws, *A*. On smaller sized units, a chain fall is not needed.

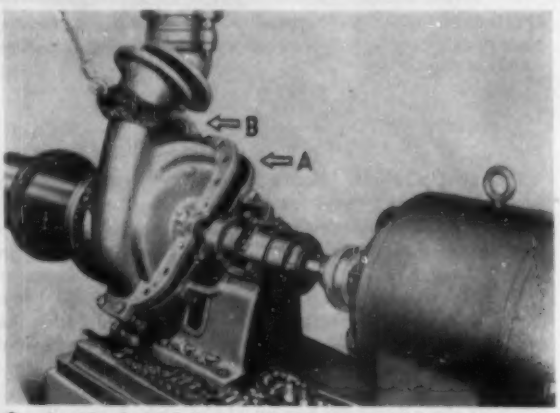
When casing is in the position shown in Fig. 4 the rotating element is easily removed after the coupling is disconnected and the bearing cap is taken off. To reassemble the pump, follow these steps in the reverse order.



1 Remove bolts between the casing and elbow *A*. Use jacking arrangement *B* to telescope discharge elbow into pipe

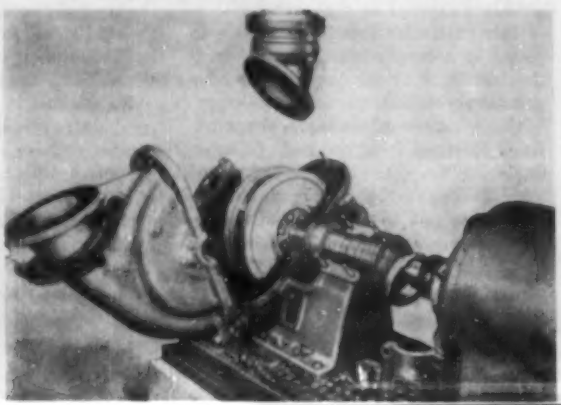


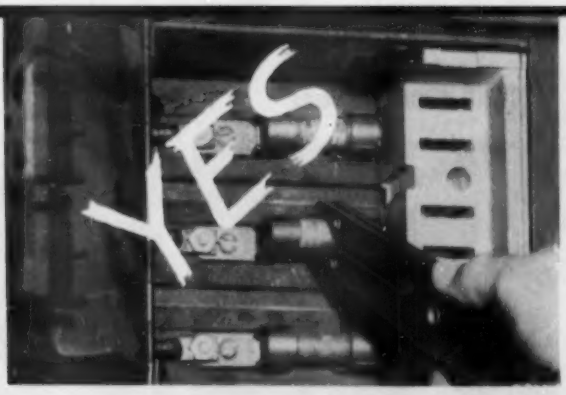
2 Loosen top nuts *C* on hinge pins. Raise casing off the sideplate locks by tightening hex nuts *D* under casing



3 Attach chain fall through space provided for it in the upper half of casing. Raise the casing by jack screws *A*

4 Pump is now open and ready for inspection or overhaul. To remove rotating element, disconnect coupling, bearing





SAFE PRACTICES prevent accidents to personnel and equipment

• 110 volts can kill a man if conditions are right—so it's worthwhile to know about the hazards of electricity, and what precautions to use in preventing electrical injury.

• It's a sure bet that those men who know the facts . . .

Don't invite an electric shock

► ACCORDING TO the latest figures available from the National Office of Vital Statistics, 1056 people were killed by electric current in 1952, in the U.S. This was a 6.9% increase from 1951. Edison Electric Institute's classification of fatal accidents within the electric light and power industry shows that electric shock or burn caused 90 deaths in that same year.

While the number may not seem large, the chances are that at least one out of five persons injured by high voltage electric shocks will die, according to Harold Vann, Safety Engineer, General Electric Company, speaking at the National Safety Congress meeting in October.

Persons injured in other types of industrial accidents usually just get hurt, most of the time not badly.

To better understand the problem, let's go briefly into three distinct phases: how you get electric shock, how it affects you, how to prevent it.

How accidents happen

The booklet "Electric shock, its causes and prevention," produced by the Bureau of Ships, U.S. Navy Department, suggests there are four causes of electric shock: (1) equipment failure (2) human failure (3) combination of equipment and human failure (4) an unlikely combination of events so unusual that even the most prudent man could hardly be expected to anticipate and guard against it.

Equipment is necessarily involved in each fatal accident. But even faulty equipment need not cause an accident if there is no human failure. Often defects in equipment could have been found by tests before a fatal accident; or were definitely known to exist before a fatal accident because of minor shocks given by the faulty equipment.

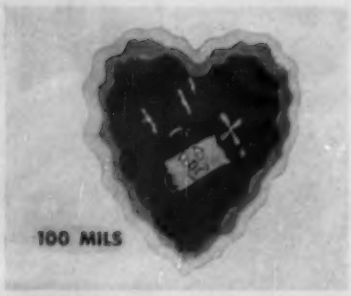
In 22 fatal shipboard accidents, four distinct human failures were noted. They could apply as well to accidents in industrial plants: (1) Unauthorized modifications to equipment or use of unauthorized equipment. (2) Failure to observe the necessary safety precautions when using or working on equipment that would be perfectly safe if handled properly. This includes failure to test whether equipment is deenergized before working on it, and careless contact with equipment or conductors that were known to be energized. (3) Failure to repair equipment that had warned of an unsafe condition by a nonfatal shock before the fatal shock. (4) Failure to test equipment for insulation resistance and correctness of ground connection after making repairs. Cutting these corners to get equipment back in service doesn't pay.

EEI's classification of fatal accidents is full of similar failures. For example, in 19 cases of fatal shock or burn at stations, on or around equipment, bus structures, etc, in 1952, men were killed by: attempting to work on live equipment next to the dead equipment they had been working on; touching or entering live equipment; slipping and falling onto station bus; working on a tap thought to be dead but actually alive. Two men were killed by fault current. One died when insulator on an air-break switch failed, the other was electrocuted when closing circuit breaker on a defective transformer.

But electrical accidents need not always be fatal. Let's see just how current affects you, and how much it takes to kill.

(Turn page)

CONTACT with 600 v circuits usually kills by destroying nerve centers



VENTRICULAR FIBRILLATION upsets heart valve action; blood can't circulate

KNOCKOUT currents to 75 mils shock and burn; seldom damage vital organs

NO VITAL ORGAN involved here, but the shock may cause unconsciousness

TYPE OF CURRENT affects the damage likely to result from electric shock

LOW VOLTAGE DC may cause involuntary reaction; high voltage, severe burns

How electricity affects men

TO A LARGE EXTENT, effect on the body is determined by the amount of current passing through it. Cartoons above and data following are from Pacific Telephone Co's slide film "This will kill you."

Currents over 2 amperes usually cause severe burns. Some are external, caused by arcing at the point of contact. Others are internal, cooking the flesh. If the victim survives, the burns heal very slowly. Either type may require amputation. Vital organs and nerve centers in the current pathway are usually destroyed or severely injured.

Currents between one and two amperes may destroy nerve centers, cause permanent or temporary paralysis of parts of the nervous system. If the pathway includes that part of the nervous system controlling breathing, victim may die. Artificial respiration may revive him, but only if heart action is strong.

Generally, deaths from contact with 600 v or more result from destruction of nerve centers by burns or paralysis.

When currents between 75 and 100 mils flow through the body, in a path that includes the heart, ventricular fibrillation may set up. Heart muscles flutter, valves get out of synchronization, seriously hindering blood circulation.

Deaths from contact with less than 600 v usually result from ventricular fibrillation. Artificial respiration has little effect.

Currents from 25 to 75 mils produce unconsciousness. They are not generally high enough to seriously damage vital organs, but may produce burns and severe shock.

How to prevent electrical accidents

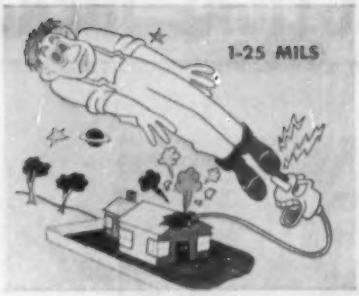
ALL CIRCUITS, even branch circuits at 120 v, are dangerous. To guard against electric shock, the Bureau of Ships booklet recommends two things: (1) See to it that your body never forms part of a closed circuit through which current can flow. (2) If this is not possible, be absolutely sure that (a) resistance in the circuit is close to infinity or (b) any difference of potential tending to cause current flow in the circuit is low or (c) resistance is high and potential difference is low.

If you let your body form part of a closed circuit where there is an appreciable voltage and low total resistance, you will never have another chance. Circuit may be closed by metallic or non-metallic conductors, or capacitors. A capacitor passes ac (and also dc when the voltage is changing) and does not open a circuit even though the plates of opposite polarity are separated by insulating material.

These precautions may save your life: (1) Make sure that you never touch a live conductor unless you are properly protected. (2) If you can't avoid touching a live conductor, then (a) kill it, plus all the other conductors you might accidentally touch, and make sure they will stay dead and (b) ground the circuit so that no voltage can exist between the line you're working on and ground.

Tag all circuit breakers and switches you have opened and all fuses you have pulled to be sure that no one reconnects them. Tags should be signed and dated, and removed only by the person who signed them.

MUSCULAR CONTRACTIONS freeze victim to circuit; someone else must free him



INVOLUNTARY REACTION may cause dangerous falls, result in serious injury

CURRENT PATHWAYS from hand to hand or from hand to feet are most common

MUSCULAR CONTRACTIONS caused by ac vary in degree with amount of current

DAMAGE INCREASES upon prolonged contact because of blistering and burning

BLISTERS form in 3 seconds with 110 v contact, greatly reducing skin resistance

Currents of about 25 mils cause muscular contractions that freeze the victim to the current. Victim must be freed by outside help. Prolonged contact lets current increase, resulting in more serious injury.

One to 25 mils flowing through the body causes dangerous involuntary reactions.

Amount of current passing through the body follows Ohm's Law. It is determined by body and skin resistance, and voltage applied. Skin resistance varies with the individual, part of the body involved, and moisture content. It may be anywhere from about 10,000 ohms on a dry fingertip to as low as 1% of this on a wet fingertip. Internal resistance from hand to hand is about 300 ohms. So if conditions are right, you can get a fatal shock from 110 v.

Current pathway also regulates the effect on the body. Rather than taking a direct route, current always spreads through the tissues. In most electrical accidents, pathway is from hand to hand or hand to feet.

Type of current influences the kind of damage. High voltage dc circuits may cause severe internal and external burns. Involuntary reaction to lower voltages may cause some other type of injury.

Greatest immediate danger from ac circuits is the muscular contractions that vary with the amount of current.

Severity of the damage always increases as contact is prolonged, because of blistering and burning at the points of contact as well as injury to the vital organs and nerve centers in the pathway. The higher the voltage, the quicker this take place. Blisters form in 7 seconds with a 50 v ac contact; in 3 seconds with 110 v.

When working on live conductors, remember that current cannot flow through your body unless it can get in and get out. Use rubber gloves if possible, to block its entrance. If you work on live conductors with your bare hand, electricity enters your body through that hand. Your safety depends on seeing that there is no point of exit, hence the use of rubber mats.

Use rubber mats or other suitable insulators to insulate yourself from (1) ground (2) all metallic or conducting structures connected to ground and (3) all conductors on the power line except the one on which you are working.

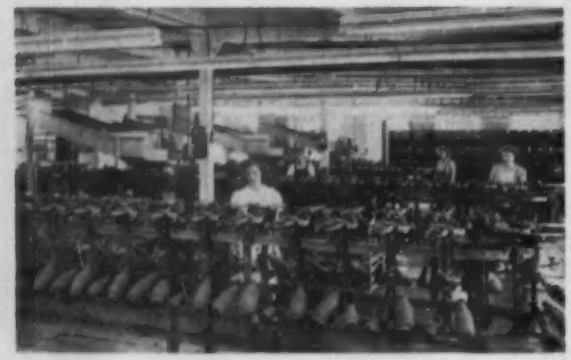
Many safety devices can be designed into electrical equipment to prevent danger to personnel. Including them is just plain common sense to eliminate unsafe conditions and prevent costly additions of safety devices after equipment is installed.

The specifications should eliminate unnecessarily exposed electrical parts and make sure that the equipment meets performance requirements. Make especially sure that portable electrical equipment is properly wired and connected to ground. This requires an adequately grounded distribution system and a receptacle to accommodate a three-prong plug. Check that breakers and control equipment have enough interrupting capacity to operate safely under short-circuit conditions.

All electric safety devices should be operative at all times. Practices like tying down interlocks and installing oversize fuses are just as foolish as holding bare energized conductors between two hands.

Check standards like the National Electrical Code for basic safety requirements for electrical equipment.

Latest PRACTICAL IDEAS to help you keep



Air conditioning *doubles* production, reduces upkeep

Textile mill shown is completely air conditioned. Results are astounding. Prior to cooling, apparatus girls in seaming department turned out 225 dozen pairs of hose. One week later, with the system hardly attuned, they seamed 444 dozen pairs. Increase of almost 100% is due to new climate.

Maintenance costs were lowered about 80%. Knitting machines 57 ft long have a high contraction and expansion value. That must be compensated for repeatedly by high-salaried mechanics because needles have only 0.002-in. clearance. No longer does a slight change in temperature or humidity need painstaking care to get the machines "back on the money." Reason is temperature and humidity are controlled within degree or two of ideal.

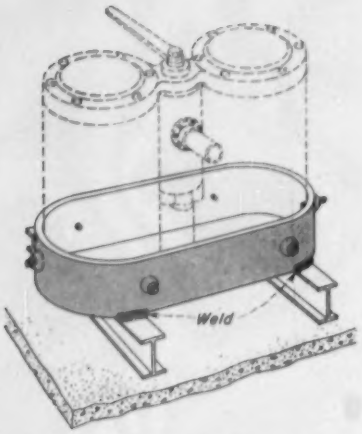
Now adjusting is just a casual, minor chore. Still another neat saving is from almost completely eliminating the laborious cleaning operation that once had to be done monthly. Today it's done only twice a year. All air circulated is filtered through glass-fiber screens before entering.

Seaming department averaged a 29% increase. This means shorter work days, no Saturday or overtime work. No grumbling by disgruntled employes. Earnings stay up. Girls on piecework increased productivity by one third.

Same ductwork is used for winter heating. Two units, one on each duct system are controlled by a thermostat and a humidistat for moisture removal in other seasons. Temperature is then controlled by reheat. In winter, a spray-type humidifier and atomizing nozzles add moisture. By these completely automatic means, temperature, humidity are kept in a narrow 4-degree band.

Air-conditioning system of this John Hardy & Son, Inc, plant is at Pulaski, Tenn. It has four 15-ton packaged watercooled units, tied into original duct system. Ducts extend throughout the mill. Louvers and take-off openings complete the picture. Calcimine-sprayed windows and other light-excluding devices fend off sun's heat. Hydraulic door closers keep precious cool air inside. All windows are kept repaired and battened down since they should never again be opened.

P C ZIEMKE *Oak Ridge, Tenn.*



Supports for strainers in earthquake area

When our steam plant was laid out, memory of the 1933 earthquake was still vivid. That's why all weights were kept as low as possible and spread over a wide area. That's the reason we selected twin condensers for main turbines, instead of turbines at higher elevation with a single condenser underneath.

These two factors also entered the design:

(1) The plant was erected on partly filled ground, subject to sinking. (2) Because of wartime materials shortage, more concrete was used than is normally the case.

Fuel-oil service pump, room and heater house were concrete, between two concrete service fuel-oil tanks. That's why we supported the twin strainer in a way to avoid movement due to seismic disturbances.

Strainer was cast iron, which ruled out welding anything to it. Strainer rests on two I beams, located to clear the bottom drains. I beams are anchor bolted to concrete-floor slab of pump room.

The steel band around the strainer is made to fit snugly around strainer. Six setscrews, in welded bosses, are tightened to take up the slack between band and strainer.

Steel band is welded to I beams to tie strainer down, as in sketch. Strainers are installed on suction side of fuel-oil pumps. Discharge-side strainers are steel to permit welding. They have welded steel supports for strength.

H T LIVINGSTON
Los Angeles, Calif.

Thanks for the dinner . . .

My wife and I had a very nice dinner on POWER last night. One of the things I like about my favorite magazine is the unexpected way checks arrive for small contributions I send occasionally to the editor.

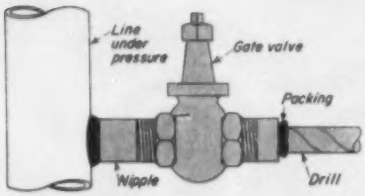
We both thank you again for dinner.

G ROSEKILLY *San Mateo, Calif.*

EDITOR'S NOTE: *Send in your electrical hookups, mechanical improvements etc, with sketches and photographs. Have a dinner on* POWER *as Rosekillys did.*

production going at top speed

STEVE ELONKA, *Associate Editor*

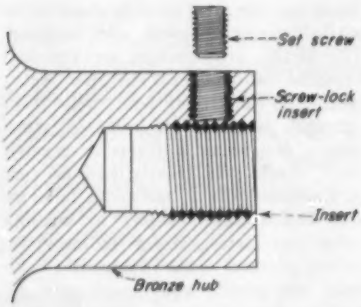


You *can* tap into live lines

SMALL CONNECTIONS are made into live lines without shutting down a system. Electric-weld a pipe nipple into live line, sketch. Screw a gate valve onto nipple, then a short nipple into valve. Next, use largest drill that will fit through nipple and valve.

After drill is in place, stuff soft packing around it. Packing revolves with drill, but keeps low-pressure steam or water away from the operator during drilling. As soon as the hole is drilled, remove drill and close gate valve. With a little care, job can be safely done in an emergency. Also use shield.

D W ANTONACCI *Bolivar, Pa.*



Two thread inserts stop hub back-off

Wire-thread inserts are used as shown to prevent a bronze hub from backing off a motor shaft. We had that trouble when motor was stopped abruptly or rotated in wrong direction.

Large standard insert provides strong permanent wear-resistant threads of stainless steel in bronze to receive motor shaft. It also acts as a brake band or clinching device. When setscrew presses against large insert, hub cannot back off. Because setscrew acts on insert and not directly on the shaft threads, these threads are not worn or marked by setscrew.

H W SMITH *Danbury, Conn.*

What would you have done?

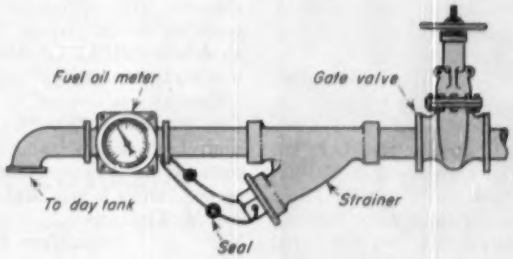
A STEEL FOUNDRY was brought almost to a standstill because of phase-to-phase-to-ground fault inside an indoor 5-kv oil circuit breaker. Breaker was in primary circuit of power transformer feeding 10-ton electric arc furnace. During maintenance, breaker tank was accidentally filled with askarel instead of maker's prescribed insulating oil.

First time the breaker was closed, the arc created gas, and an explosion followed. Insulating sleeves, around the portion of bushing conductors extending inside the tank and wooden interphase barriers, were badly charred and pitted. Plant had spare contacts and springs but no spare bushings or barriers.

While breaker was being cleaned up I had the pattern shop make new barriers from maple stock. Then we "boiled" them in insulating oil for two hours to get the moisture out. In the meantime, we cleaned up what was left of the insulating sleeves by cutting out charred portion and rebuilt to size with thick mix of plaster of paris, Glyptal.

We wrapped hardened patches with cotton tape and more Glyptal. Then we reassembled breaker, this time using insulating oil. That put the steel furnace back into business. Several months later, with 24-hr-a-day service, repairs were still OK when replaced by new factory-made parts. What would *you* have done to solve this problem?

J C ENDAHL *St. Louis, Mo.*



I placed seals on fuel line to prevent suspicion

Our hydro plant had a diesel for peaking. Fuel oil for diesel was fed to day tank in plant by gravity through a gate valve, Y strainer and meter, sketch. I'd sound the storage tank each month, checking oil on hand against amount passed through meter. One month I was a few hundred gallons short.

To prevent pilfering, I drilled a ⅛-in. hole through the plug strainers, at blowoff end, sketch. Then I threaded two meter seals—the kind used on electric meters—in series through holes in plug and up through hole in union nut on fuel-oil meter.

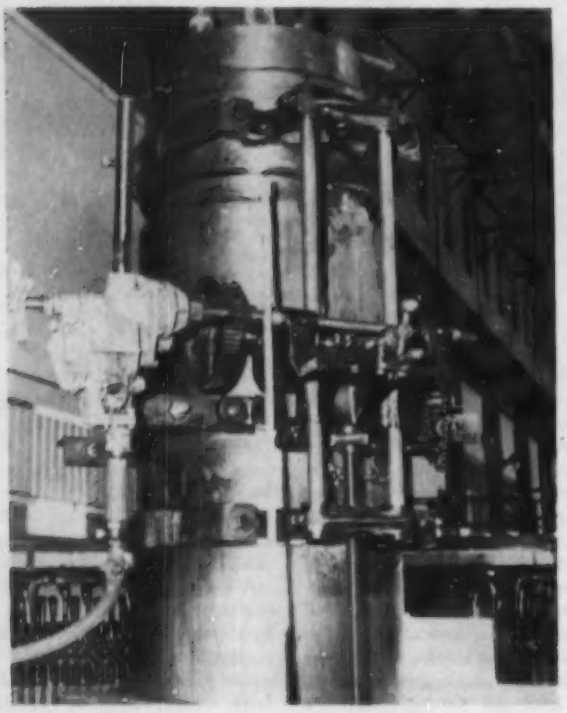
That must have done the trick because that was the end of my fuel shortage. Checking pipeline next spring showed no leaks. Even if theft wasn't the cause, meter seals protected powerplant personnel from suspicion.

A ALLEN
Siuna via Managua, Nicaragua

(*Continued on page* 132)

More PRACTICAL IDEAS

Begins on page 130



Here's your 'trick' of the month

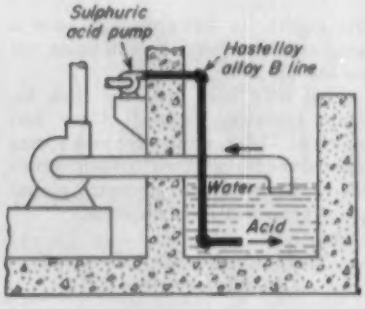
We dismantled one of our 45,000-hp turbines in our hydroelectric station recently. The longitudinal key that holds the thrust collar was very loose. Not only that—the keyway was badly chewed. Thrust collar, which supports combined weight of runner, rotor and shaft, weighs about 260 tons.

First suggestion was to remove shaft from the runner and ship it outside for repairs. This would have meant a two months' outage. Fortunately, there are still a few plants who have a Marmaduke Surfaceblow on the payroll. These old mechanics got their early training keeping plants running with few parts.

Our Marmaduke came up with the contraption shown in photo. It is an old 10-in. keyway cutting machine which he resurrected from the scrap shed. It laid there forgotten for 20 years. He got some large milling-machine cutters, made up special clamps, rigged up an air-driven drill as the motor, and rig was ready to start.

Keyway was cleaned up in five days. Cost was under $500. Had the 26-ton shaft been removed and shipped out, costs would have amounted to thousands. Here's to our Marmadukes!

L McWilliams
Shawinigan Falls, Que.



Acid feed line is no problem now

Acid feed line is used in cooling-water system for a steam condenser in new power plant. After passing through steam condenser, water is circulated over a cooling tower, then returns to a pump suction flume. Cooled water is then pumped back to condenser.

During cooling process, evaporation increases alkalinity of water. High alkalinity can lead to scale deposits in condenser and delignification of the cooling tower. To control alkalinity, measured amounts of concentrated sulfuric acid are piped into the water while it is in the flume. Acid keeps water's alkaline content at safe level.

Concentrated acid does not cause corrosion. But acid feed pipe extends down into the flume. At times, water mixes with the acid inside this ½-in. pipe. This dilute solution of acid is capable of corroding ordinary materials in short time. Now a Hastelloy alloy-B feed line is used from flume to pump. Because it's in inaccessible place where replacement is difficult, maintenance problem is avoided for years to come.

Courtesy, Haynes Stellite Co

Answer to 'We don't agree'

Sorry, Mathison, Hunter, Flack and Cannon. I don't blame you boys for not agreeing (p 126, Sept Power). Any sixth-grade school boy knows the formula: area equals diameter squared × 0.7854. Six-inch circle is 28.27 in. while a 2-in. circle is 3.142 in.

Here's why the three 2-in. meters worked for us: (1) No interruption of service if one meter fails. Other two carry service until a Dutchman is installed, meter repaired and replaced. (2) Meters are checked, serviced and repaired without cost by the water board. If failure of 2-in. meter isn't external, water board removes same, inserts Dutchman, corrects or repairs, tests, checks and reinstalls at no cost to customer. (3) If one meter fails, we can find accurate billing by reading other two meters, which indicate two thirds of total water used. But with only one meter, water used must be estimated on previous consumption records. (4) With three 2-in. meters, there's allowance for future expansion (in our case) for water demands. Example: one 3-in. meter = 315 gal per min. Three 2-in. meters = 480 gal per min. (5) With one 3-in. meter or any meter over 2 in., customer assumes having: (a) meter removed (b) Dutchman installed (c) meter crated, shipped to maker for repairs and for tests (d) meter reinstalled (e) water board notified; you must present the inspection certificate and approval from manufacturer before meter can be installed.

Believe this will show you why I can use three small meters, as I explained in my article in June Power, p 134.

B A Crosson *Cranston, R. I.*

(*More Practical Ideas, p* 134)

Architects & Engineers: Welton Becket & Associates • General Contractor: Del E. Webb Construction Co. • Plumbing Contractor: Scott Co. • Plumbing Wholesaler: Grinnell Co. of the Pacific

No need to dip your toe in this king size pool to test its temperature. Just dive right in and enjoy its filtered, comfortable water. It's thermostatically controlled by Powers.

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With its new world standards for hotel luxury, service and hospitality, the Beverly Hilton has provided its guests with the ultimate in comfort and safety in its Powers thermostatically controlled showers, shampoos and swimming pool.

More Powers to You when you want controls of superior quality that give years of dependable performance. Benefit from Powers more than 60 years of experience in temperature control. Call our nearest office or write us direct for aid in selecting the right type of control for your requirements.

(c47)

Safe, Comfortable Showers, 450 of them in the hotel and colorful pool side cabanas, are thermostatically regulated by Powers. There is no danger of scalding or unexpected shots of cold water.

No Danger of Scalding in the Barber Shop Shampoos. They're safetyized by Powers.

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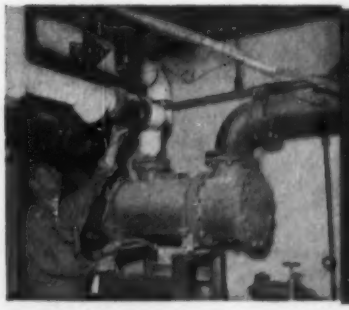
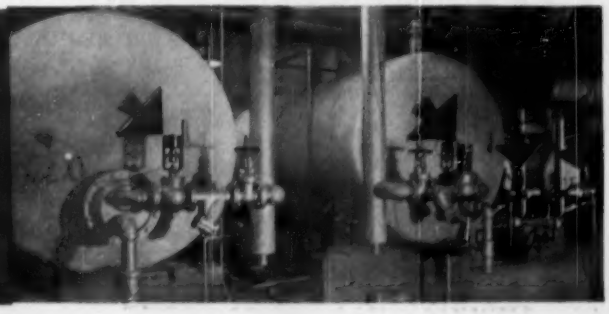
Over 60 years of Automatic Temperature and Humidity Control



5 of the 8 Powers Controlled Water Heaters

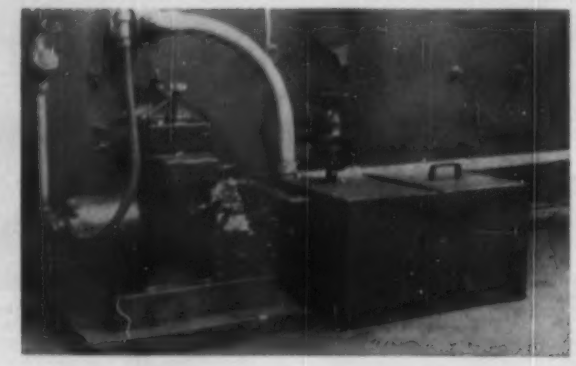
Heat Exchanger, left, supplies properly tempered water to swimming pool.

Water Storage Heaters, right, are also controlled by Powers No. 11 Self Operating Temperature Regulators.



More PRACTICAL IDEAS

Begins on page 130

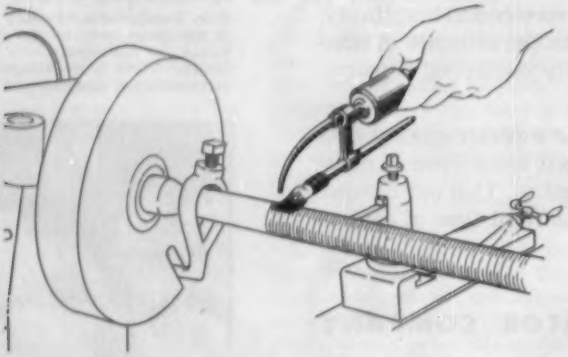


Now, no more oil lost to sewer

We operate a turbine oil-centrifuge continuously eight hours each day. When centrifuge got dirty or didn't work right, turbine oil was lost to sewer. If shift operators weren't on job, we'd lose about one-half barrel of turbine oil in a few hours' time. Centrifuge pumps oil from reservoir tank to main turbine-oil tank, then overflows back into reservoir tank by gravity.

To eliminate oil loss, I made tank as in photo. It has float and alarm switch to notify operator when tank level is high. Then he can shut down centrifuge and clean or correct trouble. Tank is also hooked up so oil can be pumped back into system if it fills with oil. A drain on back of tank empties water from tank to sewer.

C J WERDERITCH *Clinton, Iowa*



Brush and oil can do better job here

Usually oil can is used for cutting fluid when turning or threading in lathe. But it doesn't always work right. Not only is oil wasted, but excess fluid is splashed on operator too. My applicator, shown, is made of a drip oiler and a cheap paint brush. Oil is spread on evenly and chips are cleared from previous cuts as brush spreads the oil.

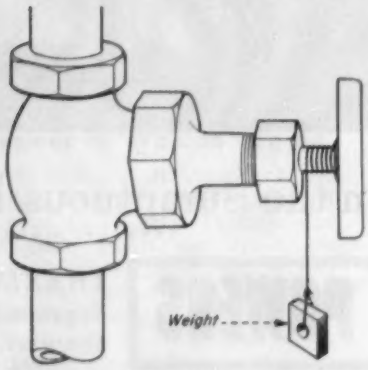
N K RAFANAN *Cebu City, P. I.*

Handy tool for removing oil-drum plugs

Enthusiasm of oil-drum makers knows no end when it comes to variety of inserts for plugs of their oil drums. Squares, rhombuses, stars, deltas, parallelograms and a dozen others cover all geometric designs. Tools used to get one type out are useless on others.

Simple little tool in sketch can be used to remove many of them without trying to find out why one wrench to take them all out was never made. Tool can be of any soft-iron square stock. It's safe to use. Ordinary small "crescent" wrench is OK to work the most obstinate plug loose. But you can make a small wrench to rip off the cap seals. This wrench is handy, as shown.

T HOLLORAN *Scarboro, Ontario, Can.*

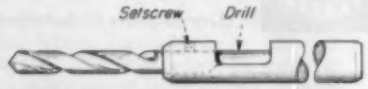


Weight acts as telltale for valve

Some equipment has valves that have to be closed at shutdowns. Then operator often forgets to open them before starting up. For valves in a horizontal position, cord and weight in sketch solve the problem.

Operator can tell at a glance if valve is open or shut. Cord tied to wheel wraps around stem, raises or lowers weight. To give better contrast, paint the valve wheel and traveling weight in contrasting, eye-catching colors.

T HOLLORAN *Scarboro, Ontario, Can.*

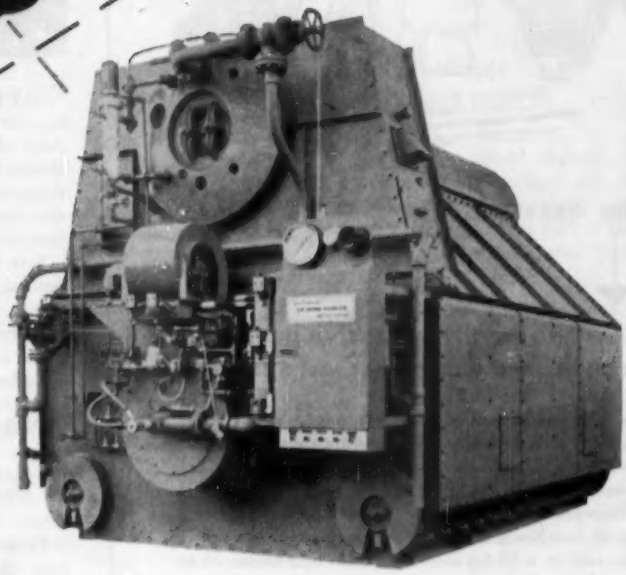


Drill stretcher

Extension shown is handy for drilling a hole in an inaccessible place or for lengthening a short drill bit. First, drill one end of a steel rod to a depth of ½ in. Grind flat halfway through, as shown at bottom of hole. Next, grind the drill at shank end to fit flat on steel rod. Then drill and tap for Allen setscrew to hold the drill to rod. This method of coupling may also be used for hand taps and similar tools that are short.

N K RAFANAN *Cebu, P. I.*

YARWAYS for WICKES



this

package boiler maker

selects

Yarway Blow-Off Valves

The Wickes Boiler Co. selects Yarway Seatless Blow-Off Valves to make their good package-type boiler even *better*.

Most package boiler users insist on Yarways . . . and most boiler manufacturers supply them.

This acceptance is growing fast. *Dependability* and *low maintenance* are two of the reasons. Rugged, safe Yarway Seatless Blow-Off Valves *have no seat to score, wear, clog or leak.*

Yarway Blow-Off Valves are used today in over 16,000 boiler plants. Many of these valves have been in *continuous* service 20, 30 and 40 years.

For the full story on blow-off valves to meet your pressure requirements, write for Yarway Bulletin B-426.

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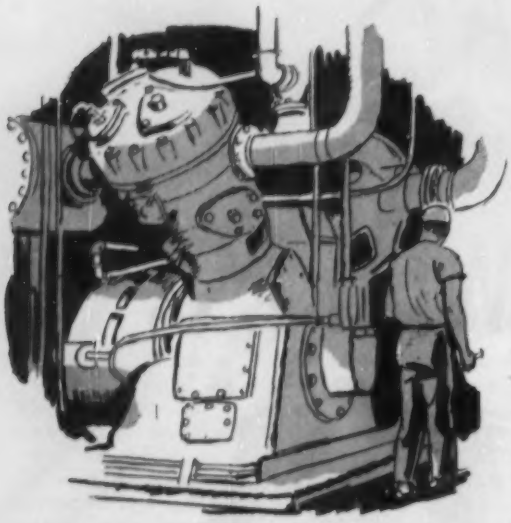
YARWAY

BLOW-OFF VALVES

Solving PLANT PROBLEMS *... readers*



The question

How can I avoid excessive pressure drop in our compressed-air system?

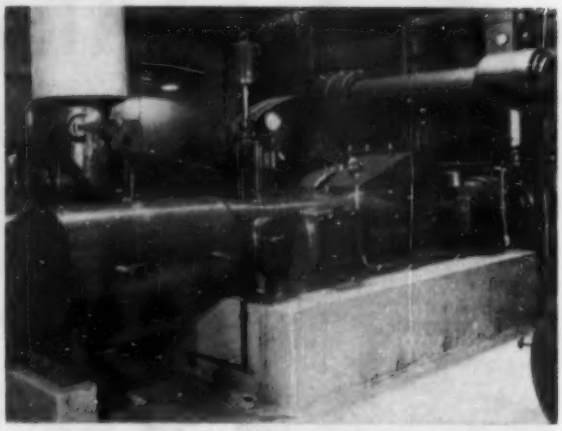
I'm responsible for power services in a good-size foundry that's about to expand its compressed air system. We use compressed air for molding, sand ramming and a multitude of other purposes.

Compressor we're buying is a single-stage, horizontal, double-acting, motor-driven machine that's powered by a 50-hp motor. Piston displacement is 350 cfm at 100 psig.

Our present machines, also rated at 100 psig, have difficulty maintaining the required pressure at the pneumatic tools. We've checked tool manufacturer's recommendations and feel we have enough compressor capacity to supply the tools.

As I see it, either our distribution piping system is poorly designed or we're losing air through leaks. Naturally, we want to rectify our mistakes when we install the new compressor. Can readers offer advice on avoiding excessive pressure drop?—*AL, Sept Power*

The answers



Pointers in planning compressed air

Area of the suction line from filter to compressor connection should be no less than 25% of the air-piston area for a single-stage, double-acting compressor such as AL is buying. Suction line diameter should be boosted one inch for every 10 feet of length.

Size the compressor discharge line to match the compressor connection. And increase its size one inch for every 10 feet of length.

Aftercooler with separator is a big help, since it eliminates *wet air* which washes away pneumatic tool lubricant. An aftercooler also does away with big temperature differences in the distribution line.

Peak load demands determine size of a primary air receiver. Generally, receiver volume should be no less than one-tenth the cubic feet of free air per minute displaced by the compressor. In AL's case, assuming an 84% volumetric efficiency, a 30-cu-ft receiver would be warranted.

Pressure drop from primary receiver to load points is best kept to 5 psig or less, insuring pressure at tools.

R L Theiss — *Akron, Ohio*

Loop system is most dependable

Loop system throughout the building provides two-way distribution to the area having the greatest demand. And with the right valving arrangement air can be delivered to any part of the plant—even if a section of piping is out of service.

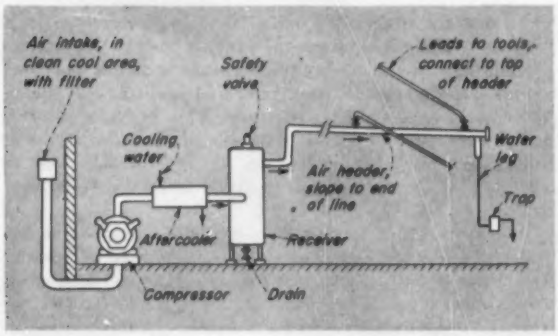
Long pipe lines must have receivers at their far ends or in heavy-demand areas. Peak loads for compressed air are usually of short duration. And by having storage capacity in areas where peaks occur, AL can avoid excessive pressure drop.

Location of compressors is important too. A central location permits better supervision. And no more compressors need be operating than necessary to provide adequate pressure. Also there's less tendency to neglect routine inspection, maintenance, an important item in compressor operation.

H B Wayne — *Brooklyn, N. Y.*

cure each other's headaches

HOWARD KALLEN, *Assistant Editor*



Design tips for air systems

Good distribution piping design is essential to an efficient compressed air system. AL should size the header for minimum pressure drop. Tables in the Compressed Air Handbook of the Compressed Air and Gas Institute, give pressure drop for different pipe sizes and flows.

System should include the features shown in the sketch above. If practical, locate the compressor against an outside wall and extend suction piping 8 to 10 feet above grade—or high enough to insure clean, cool air. Filter on inlet keeps out dirt.

Figure header size on the basis of air volume and distance it must travel. For instance, if maximum air flow is 500 cfm, the pressure drop in 1000 feet of 3-inch pipe is 2.34 psi—an acceptable loss.

The header should be free of dips and sags and slope away from the receiver to the far end.

A E PRITCHARD *Jennings, Mo.*

Install small receivers close to tools

We've had success with AL's problem, by installing small air receivers close to air using equipment.

Our compressors with their main receiver are a considerable distance from using areas. Before auxiliary receivers were added, air supply was inadequate and pressures erratic. Since installing the receivers we've had no more trouble.

The small tanks are 5 to 10 cubic feet and are coded pressure vessels. Delivery pressure is about 85 psi.

T H MCCARTHY *E I du Pont de Nemours & Co So San Francisco, Calif.*

Gages can pin down trouble

In too many cases pressure receives full attention while volume is ignored. The main air distribution header must have greater capacity than the total of all lines leading away from it.

On an existing system, locate gages at different points. This isolates the bottleneck. A restriction in the line or undersized line might be the cause.

E L THOMAS *Hapeville, Ga.*

Oversized distribution lines pay off

AL should make a layout of the foundry to get the most direct possible route from compressors to the air tools. A loop distribution system is better than a dead-end pipe line. And an auxiliary receiver in middle of the loop helps avoid excessive pressure drop.

Run branch lines as close as possible to air takeoff points to keep hose lengths short. Branch lines should have enough capacity to supply the maximum number of hoses connected to them.

In a foundry compressed-air piping cost is small compared with total cost of the plant. So cost of oversized piping is quickly offset by savings resulting from adequate air pressure at pneumatically operated tools.

H T LIVINGSTON *Los Angeles, Calif.*

How to figure air leakage loss

If AL's distribution mains are leaking, he can use the following method to figure the amount of leakage:

First, estimate total system volume from receiver stop valve to the tools. This estimate should include all separators and branches. Next, with all air using equipment shut off, close the main stop valve and measure time it takes for system pressure to drop 15 psig, with a stop watch. Leakage loss is:

Cfm loss = system volume, cu ft ÷ time for 15 psi drop.

F H SCHADENDORF *Boys Town, Neb.*

Take current readings on motor

Trouble could be that the compressors themselves are not putting out their rated capacities due to dirty or scored valves, worn piston rings or cylinders. These are often overlooked because the machine *sounds* good and carries full pressure under light loads.

Taking current readings of the motor with compressor loaded and up to rated pressure is a good check. These readings are then compared to manufacturer's motor requirements to see if compressor is operating at rated load.

P DAVIDSON *Ticonderoga, N. Y.*

Even small leaks are serious

At a system pressure of 100 psig, about 26-cfm free air escapes to the atmosphere through a ⅛-in. diameter hole. Volume is proportional to the area of the hole and to the absolute pressure in the system. Thus, ten ⅛-in. holes pass about 260-cfm free air at 100 psig. At 80 psig they'll pass 215 cfm.

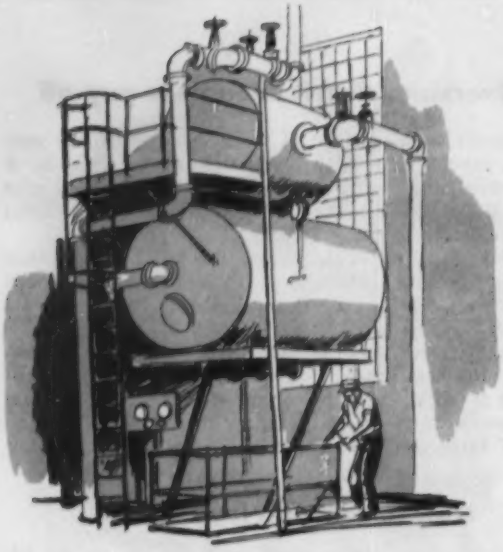
Although these figures apply to round orifices only, they show how important even small leaks can be in compressed air systems where operating at full capacity is important.

R A LEUCHTER *Montreal, Canada*

Turn page for info on taking deaerator out of service.

More PLANT PROBLEMS

Begins on page 136



The question

What's best way to take deaerator out of service while under load?

Our deaerating heater, mounted on a storage tank, serves two 200,000-lb-per-hr boilers whose steam conditions are 900 psig, 950 F. Water entering deaerator is 180 F, 110 psig, while steam entering it is 550 F, 110 psig.

The storage tank holds 125,000 lb of 110-psig saturated water. The boiler feedwater is regulated by 3-element controls.

The deaerator level-control valve is equipped with block and bypass valves, and the deaerator and storage tank can be bypassed through a line that leads from booster pumps to boiler-feed pumps.

We want to cut out the deaerator to replace some valves. But we want the colder feedwater to have least possible effect on boiler operation and combustion conditions.

Will readers give us their recommendations on how to go about this?—*HS, Sept Power*

The answers

Bypassing deaerator can cause boiler corrosion

Bypassing the deaerating heater should not be done in a heat cycle generating steam as high as 950 F. Deaerators are placed in a feedwater cycle to serve a double purpose: (1) To raise feedwater temperature 60 to 70 F. (2) Bring water to its saturation temperature. This liberates noncondensable gases present. The deaerating heater also serves to collect and mix the high-pressure heater drains as well as leakoffs and balancing drum leakage from the boiler-feed pumps.

To carry out what HS has in mind would require rerouting drains and vents from higher-pressure heaters as well as the lines from pumps. Extraction-steam supply valve must be closed, forcing additional steam through the remaining heaters. And bypassing the level-control valve disrupts continuity of feedwater flow regulation to the boiler.

Feedwater temperature to the boiler is not affected since the heaters will be receiving more steam than normal from the turbine, resulting in a higher terminal temperature difference in each heater. This, in turn puts more load on the heater-drain pumps. HS should check them to see whether they can be operated continuously at the heavier load.

Most serious effect of bypassing the deaerator is carryover into the boiler of higher-oxygen-content feedwater, the main cause of corrosion.

HS should reconsider his idea, or do the maintenance during a scheduled shutdown of the unit. Or—if absolutely necessary—remove the deaerator from service during a low-load-demand period and repair the valves.

If valve maintenance calls for emptying the deaerator then HS should consider draining it into another tank for temporary storage. Water transfer can be handled through an existing line, either from the drain connections on bottom of the storage tank or by pumping from the discharge header of the boiler-feed pumping system.

A J Breugelmans — *New York, N. Y.*

Tip to HS: Cutting out deaerator under load is asking for trouble

HS's best bet is not to cut out the deaerator. In fact it's the only smart thing to do if he doesn't want to risk an extended forced outage on the boiler.

From an economic viewpoint, taking the deaerating heater out of service trims down cycle efficiency, boiler capacity. But even more important, feeding raw condensate and makeup water into a high-pressure boiler without heating and deaeration, can lead to serious trouble—and here's the reason why:

When boiler is operating, its drum and internals are extremely hot. Injecting relatively cool water on these surfaces produces unequal expansion in the shell and riveted joints. Result: Leakage at the joints and decreased boiler life. In addition, too much mud forms in the drum during light loads, clogging passages at bottom of the front waterwall tubes. Eventually blistering occurs and tubes split.

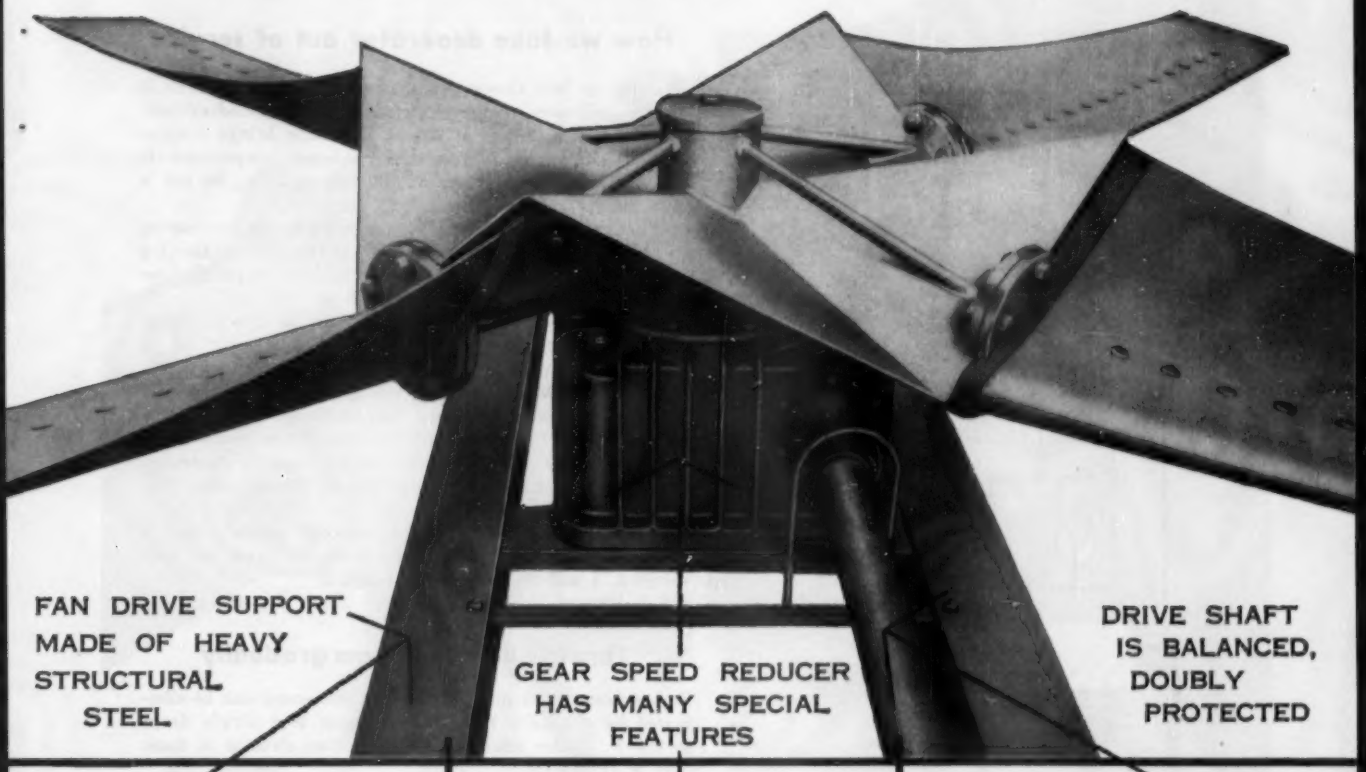
Oxygen and carbon dioxide also corrode the internals.

J Schneider — *Needham, Mass.*

(*Continued on page* 140)

ONE MORE REASON TO CHOOSE PRITCHARD COOLING TOWERS:

PRITCHARD DRIVE ASSEMBLY IS BIGGER, BETTER, MORE STRONGLY SUPPORTED!


FAN DRIVE SUPPORT MADE OF HEAVY STRUCTURAL STEEL
GEAR SPEED REDUCER HAS MANY SPECIAL FEATURES
DRIVE SHAFT IS BALANCED, DOUBLY PROTECTED

The fan drive support on all Pritchard cooling towers is one-piece, welded construction; made of heavy structural steel. After the gear speed reducer and driver are aligned, the driver and reducer are doweled for permanent alignment. This insures permanency of drive alignment regardless of settlement in the tower structure. The support transmits operating and dead load uniformly to the tower framework.

Pritchard gear speed reducers have many special features: superior shaft seals, heavier bearings, more conservative horsepower ratings, more rigid housings, more positive lubrication than any other gear speed reducer available. They are manufactured by old-line speed reducer makers especially for the rigorous service demanded on cooling towers and carry an AGMA label certifying their ratings.

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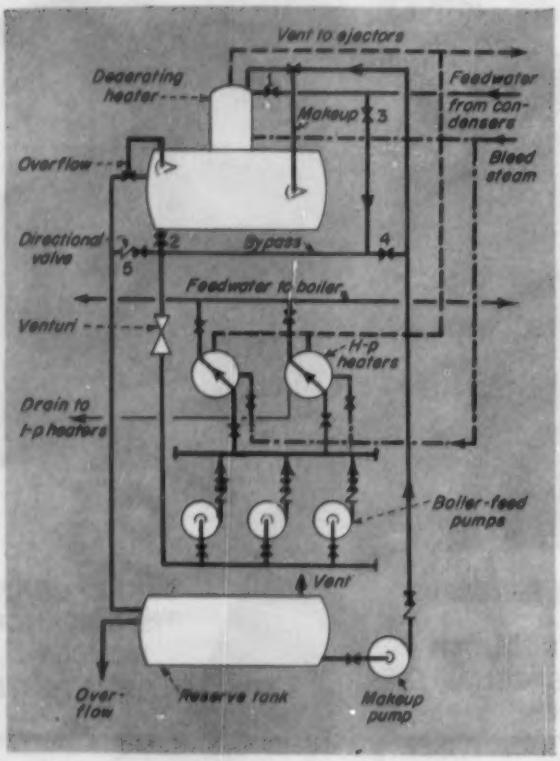
More PLANT PROBLEMS

Begins on page 136



How we take deaerator out of service

Drawing at left shows our system hookup. We normally deliver feedwater to the deaerator from intermediate-pressure feedwater heaters at 266 F. Deaerator brings it up to 280 F. High-pressure feed heaters boost temperature to 338 F. One h-p heater can handle full capacity. So one is always in reserve.

When our deaerator is out of service for repair or cleaning we bypass feedwater around the deaerator, to the h-p heaters. By running both of these heaters in parallel we can bring feedwater up to 338 F.

A venturi in the boiler-feed-pump suction line allows us to treat feedwater chemically to eliminate oxygen.

The reserve tank contains feedwater for emergency conditions. When the deaerator is out of service and feedwater demand exceeds supply from the condenser, we make up the difference from the reserve tank. When demand for feedwater is less than condensate coming from the condenser, we discharge the excess through the directional valve, into the reserve tank.

With the deaerator in service, we open valves 1 and 2, close valves 3, 4 and 5. With the deaerator down, we open valves 3, 4 and 5, close valves 1 and 2.

J H Riviere — *Santa Fe, Argentina*

Throttle heating steam gradually

Temperature shock due to cutting out deaerator can be eliminated by gradually throttling steam so feed slowly drops to 180 F. Boiler efficiency suffers but no damage is done.

D W Hallman — *Emmaus, Pa.*

YOUR DECEMBER PROBLEMS

1 How can I avoid water hammer in this liquid line?

As plant engineer for a relatively small-sized chemical plant, I'm responsible for process piping as well as power services.

In one of our operations we have to use a quick-opening valve in a liquid line that feeds into a chemical mixing tank. Length of line is considerable —about 200 ft. It's 2-in. diameter, nominal. Liquid flowing is a cold chemical solution.

I figure that, based on known flow and pipe cross-sectional area, liquid velocity is 10 ft per sec. It's on the high side for such an operation.

Whenever we find it necessary to shut off the quick-opening valve before the chemical-mixing tank we get a severe water-hammer condition. In addition to being a major nuisance, we're afraid it will damage the piping system.

Do *Power* readers know how I can modify the system to reduce or eliminate the water hammer?—*JT*

2 What's best way to control feedwater heater?

We're planning to install several new feedwater heaters in our municipal power plant. Turbine cycle these heaters will serve generates 20,000 kw. Turbine has four extraction points, ranging from 10 to 200 psig. Main steam conditions are 600 psig, 800 F. Second heater in the system is open type, deaerating, operating at 40 psig.

Of the three closed feedwater heaters, two will be vertical, one horizontal. Cycle is set up so condensate in heaters flash back to lower stages. Heaters will also be equipped with condensate subcooling sections.

We'd like to know the best way of controlling condensate drainage in these heaters. We naturally want to avoid blowing live steam along with condensate to lower stages. On the other hand, we don't want to submerge active condensing surface and ruin feedwater heater performance, hurt cycle efficiency.—*LL*

Sit down right now and answer one or both of these problems. We'll pay extra for answers with photos or sketches.

BETZ. *A Great Name In Water Conditioning*

Engineer at work!

If you were to walk into the Engineering Department of our Philadelphia headquarters, chances are you'd see a vacant desk or two like this. And for good reason!

The engineer who occupies this desk might be in Maine, California, Texas . . . anywhere in the country providing supplemental assistance on water problems . . . helping your *personal* representative, the Betz District Engineer and *you* to do a better job in your plant.

He's one of a group of over 20 Betz specialists that make up our fully-staffed Engineering Department . . . providing *additional* headquarters engineering support as well as in-the-field engineering as required.

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CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

ARGUMENTS . . . pros and cons from readers' letters

ALTHEA THORNTON, *Assistant Editor*

Why not use right terminology?

My beef is the misuse of engineering terms. One example is the word *adiabatic,* frequently used to describe blower performance. An adiabatic or isenthalpic process is a constant heat reaction, whereby heat content or enthalpy does not change and no work is performed. When discussing blower performance, *isentropic* is the correct term for reversible compression. It is a measure of available heat converted to work.

The word *vacuum* is widely misused when discussing steam turbine performance. Actually, it is *backpressure* that influences the performance. A difference in atmospheric pressure changes the vacuum even though the backpressure is constant.

For example, a backpressure of 2 in. Hg absolute is about 27.92 in. Hg vacuum at sea level, but only 18.58 in. at 10,000-ft elevation. Although a barometer reading is usually referred to, vacuum is not the parameter to use here.

Another term used incorrectly is *expansion* tank, describing the cooling-water receiver for a diesel engine. Since water is practically incompressible for the temperature ranges normally encountered, *surge* tank is more suitable.

H B WAYNE *Brooklyn, N. Y.*

EDITOR'S NOTE: *Do you readers agree with Wayne? Are other engineering terms misused in plants you know of?*

Which size is better for feed-pump suction lines?

'Small'—says Edwards

I read D C Swift's article, "Operating details for feedwater heaters, deaerators and pumps" in July POWER with interest. But he erred in two items under, "Deaerator Troubles" (p 180).

In item 3, he speaks of "liberally sized suction lines." While from the point of view of friction losses only, this is perfectly correct, he apparently does not take into account the important matter of transient operation. But in the previous paragraph he does mention transients.

Basically, the larger the water volume in suction lines at initial temperature, the longer the residence time, and the more severe the flashing during a sudden load drop. So large suction piping with low friction losses must be evaluated against small suction piping with low residence time.

In item 4, he speaks of so-called antiflash baffling. Recent tests indicate that the action of antiflash baffling occurs too late, and boiler-feed-pump damage may have already taken place before its effects have been felt.

T W EDWARDS
Worthington Corp, Harrison, N. J.

'Liberal'—says Swift

When a turbine suddenly drops load, and pressure in the bleed line falls below deaerator pressure, the check valve or nonreturn valve in the bleed line should close to prevent steam flow reversal and possible turbine overspeeding. Assuming that check valve closes properly, the deaerator pressure remains substantially at its value before turbine load drop, if no cold water from the condenser and other heaters enters. But controls on condenser level normally let condensate flow continue for several minutes without much decrease.

This cold entering water makes deaerator pressure drop rapidly. Then pressure on the water in deaerator storage tank is relieved, allowing it to flash. Steam thus released flows back into the deaerator to help heat the incoming cool water. Cool water's inflow rate, as related to amount of water in the storage tank, determines the rate of deaerator pressure drop.

Water flashing fills the deaerator tank with steam bubbles that tend to rise to the surface. A pipe channel or antiflash baffle in the storage tank channels the cooler water from the deaerator down to the feed-pump suction header. This tends to avoid flashing and isolates the steam bubbles being released in other parts of the storage tank.

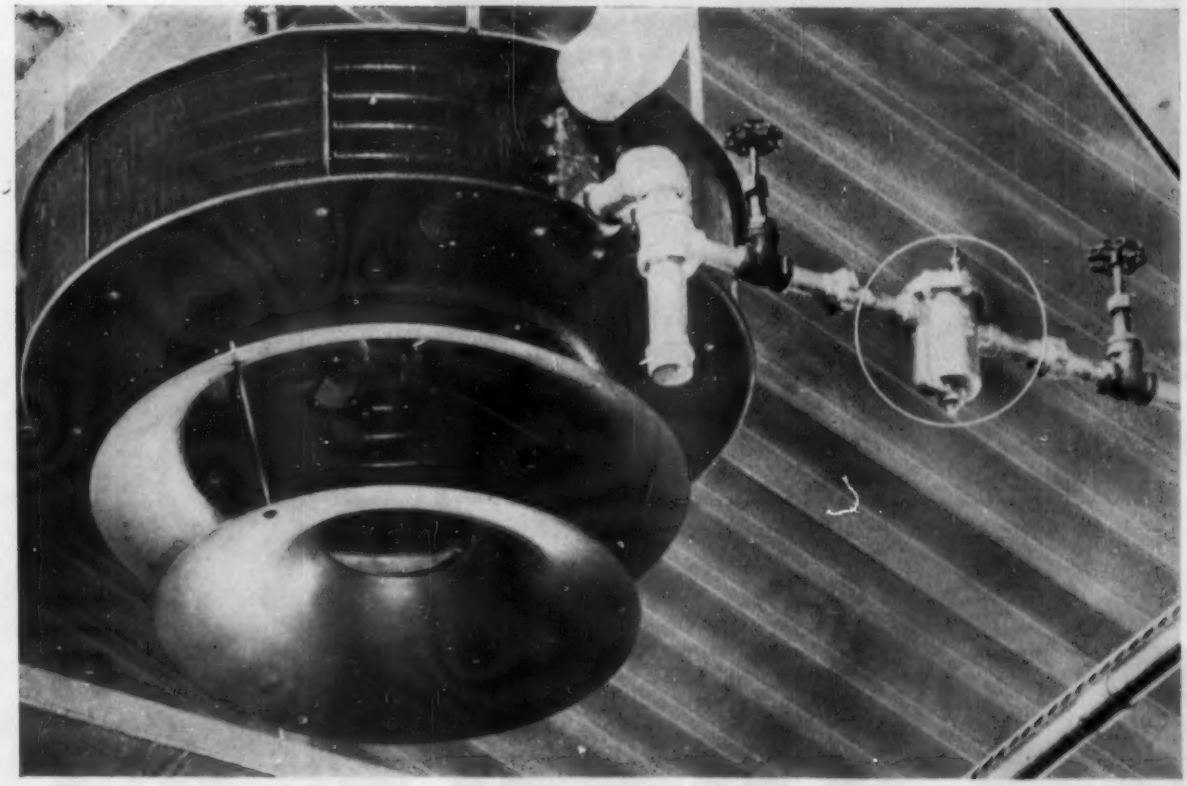
If turbine load is dropped suddenly, the boiler safety valves may open for a short period. When firing rate has been adjusted to the new steam demand, the valves should close. Boiler-water level then tends to drop, depending on boiler type, change in steaming rate, type of feedwater control and other minor factors.

Demand for feedwater may then rise substantially above full-load rating for a short time. If deaerator pressure is falling rapidly, you may get flashing in the suction lines from deaerator storage tank to feed pump. If steam bub-

(*Continued on page* 198)

NEED EXTRA DOLLARS?

Power pays readers who send in Arguments for this page



Here's the Way to Trap a Unit Heater for Lots of Heat and Little Maintenance

The picture above is an outstanding guide to good unit heater trapping. This installation provides maximum heater efficiency and minimum maintenance time and cost.

1. Simplified piping. Horizontal in-line piping is made possible by the Armstrong side inlet—side outlet trap body. Note that the trap can be opened by removing the cap, without disturbing pipe connections.

2. Dirt pocket ahead of trap. The vertical pipe leg collects heavy dirt and scale. No strainer is needed because the self-scrubbing action of an Armstrong trap washes ordinary dirt right through it.

3. Test valve. The maintenance engineer can check this trap quickly and easily by opening the test cock shown installed in the trap cap.

4. Shut-off valves and unions. The trap can be repaired, or replaced with a spare trap, without shutting off any other units.

5. Generous sized trap. The Armstrong trap, selected from Table B-29 or C-29 in The Armstrong Steam Trap Book, provides a minimum safety factor of 3 to 1 for this job. Its big air handling capacity keeps the heater free of corrosion-producing air and CO_2, provides fast heat-up and full rated btu output. No lag—condensate is discharged at steam temperature.

6. A good steam trap. The Armstrong trap discharges condensate at steam temperature and it has large air venting capacity. The heater is always full of hot, dry steam.

The Armstrong trap mechanism cannot clog, bind, stick or collapse. Valve and seat are hardened chrome steel—all other working parts are stainless.

An Armstrong trap is rated conservatively on a basis of actual hot condensate capacity under job operating conditions. This is not true of all traps and is an important factor when comparing prices.

Armstrong traps are sold by factory-trained Representatives under an unconditional, money-back guarantee of satisfaction to the user.

For the best in unit heater trapping, call your local Armstrong Representative, or write:

ARMSTRONG MACHINE WORKS
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FREE — "How to Trap Unit Heaters" is the title of pages 28 and 29 in The Armstrong Steam Trap Book. This 44-page catalog is a guide to good trapping practice. Send for your copy.

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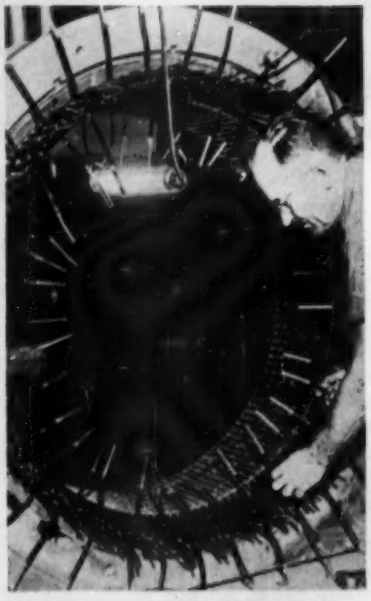


to rebuild electric motors

HOW TO
light up dark spots

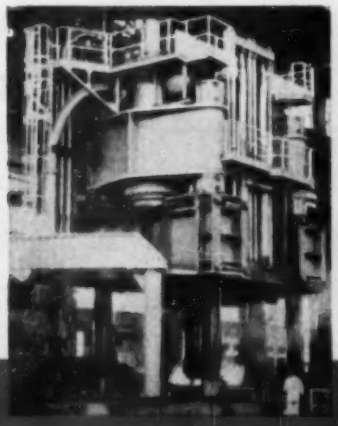
► YOU OFTEN have to light up hard-to-reach dark spots with a safe, easy-to-handle portable light. Now, here is a fluorescent work lamp that is glarefree, cool and easy to handle. Light is insulated, water- and vapor-tight to conform to safety engineers' requirements in hazardous locations. That's important.

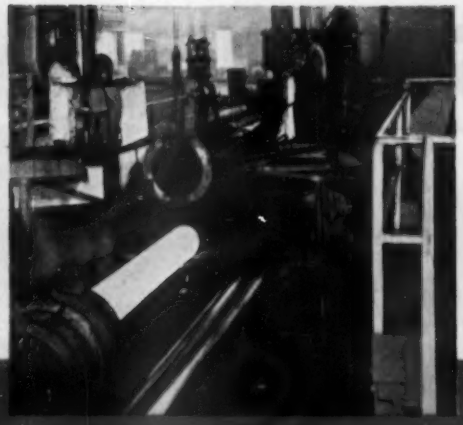
This lamp is both rugged and easy to hook on wherever it may be needed.

Another feature is that more light is supplied, making the maintenance worker's job easier, quicker. Lights come in sizes up to 30 watts. As photos show, they are small enough in diameter to place inside a drum, yet give off sufficient glarefree light to be practical.

And don't forget the safety feature.

Courtesy, The Day-Ray Company, South Pasadena, California.





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ASTM A 106 Grade B	Carbon Moly High Silicon	P 15	Croloy 18-8 Ti	TP 321
ASTM A 106 Grade C	Croloy ½	P 2	Croloy 18-8 Cb-Ta	TP 347 (Cb-Ta)
	Croloy 1	P 12	Croloy 18-8 Cb	TP 347 (Cb)
	Croloy 1¼	P 11	Croloy 16-13-3	TP 316
	Croloy 1¾	P 3		
	Croloy 2	P 3b		
	Croloy 2¼	P 22		
	Croloy 3M	P 21		
	Croloy 5	P 5		
	Croloy 5 Si	P 5b		
	Croloy 7	P 7		
	Croloy 9-M	P 9		
Analyses such as SAE or AISI carbon steel will be considered if quantities are sufficient.	ASTM Spec. A 335 has superseded and replaced ASTM Specs. A 158, A 206, A 280 and A 315.		These grades will also be made to ASTM specification A 376 excluding "special inspection" requirements.	
	This list includes all grades of A 335 except grade P 5c, which we do not make.		Other grades of Stainless Steel listed under A 312 are TP 309, TP 310, TP 317. These grades are presently not offered as standard, but will be considered on request.	
	B&W Croloys, 2½, 3, 5M, 7M, and 9, are not included in A 335. We will supply these additional alloys in accordance with A 335, except for chemistry, upon request.			

For the complete B&W Hollow Forgings story, send for new Bulletin S-16B. The Babcock & Wilcox Company, Process Equipment Department, Barberton, Ohio.

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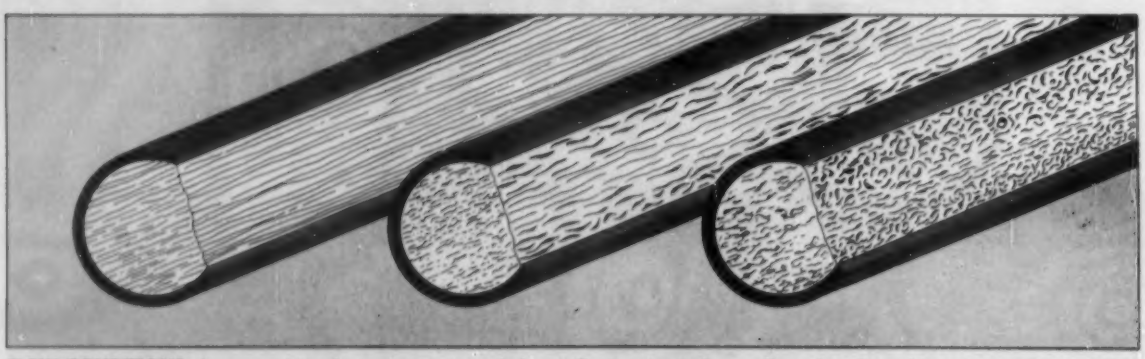
BOILER DIVISION

S-441

BASICS . . . *bringing engineering theory down to earth*

HOWARD KALLEN, *Assistant Editor*



FLOW CONDITIONS show transition from viscous to turbulent. Center pipe indicates flow when Reynolds number reaches critical

FLUID FACTS — 4

Flow conditions . . . viscous or turbulent?

► So FAR, we've concentrated on fluid properties—density and viscosity—and fluids at rest. With this installment we begin to study fluid flow.

Predicting the action of moving fluids is far from an exact science. Lack of basic information forces us to use approximate formulas, based partly on mathematical analysis, but mainly on experimental data. For most common engineering problems available data are OK, but we should know what their limitations are, where and how to apply them.

Moving fluids fall into two classes, viscous (also called laminar) and turbulent. To understand difference between them let's run a simple test. We'll add colored fluid streams to low-velocity liquid flowing in a glass pipe. As long as liquid's velocity is relatively low, colored fluid streams move along with water, almost parallel to pipe wall. Liquid particles are actually moving parallel to pipe wall. We could picture this action as a large number of thin concentric layers or cylinders. Liquid's viscosity causes substantial shearing action between layers, keeps moving layers parallel—as long as velocity doesn't get too high. Hence, the term viscous flow.

Let's see what happens when we gradually speed up liquid flow. At first, flow remains viscous. But at a certain speed (critical velocity) colored flow lines begin to break up. Fluid is no longer moving in parallel layers. If we hold liquid at this velocity, flow-line breakup isn't complete. We're actually in a transition stage. But, with further velocity increase, coloring diffuses throughout the moving fluid. We're now in the turbulent-flow region.

Fluid particles no longer move parallel to pipe. They move in all directions through the flow, colliding with and sliding over each other. And liquid's viscosity doesn't play the key role that it does in viscous flow. Shearing action is due to momentum changes as particles collide, rather than viscosity effects.

Test similar to the one we've just described was made in 1883 by O Reynolds, a well-known English scientist. But he went one step farther. Reversing the test, he found that transition velocity in going from turbulent to viscous flow was less than the first transition velocity he spotted. So there's an upper and lower critical velocity bracketing the transition region.

From this and other tests Reynolds also noted that whether flow is viscous or turbulent depends also on pipe diameter, fluid's viscosity and density. He combined all these factors in a single term—the Reynolds number. We use it as the criterion for viscous and turbulent flow:

$$R = dVD/u$$

Where

R = Reynolds number, dimensionless
d = density, lb per cu ft
V = velocity, ft per sec
D = pipe internal dia, ft
u = absolute viscosity, lb per ft-sec

To use the formula we have to convert metric viscosity units, centipoises, to English units, lb per ft-sec. Here's conversion factor:

Centipoises × 0.000672 = lb per ft-sec

At Reynolds numbers below 1200, flow is viscous. Above 2200 we get turbulent flow. Between these two figures we're in the transition region. But for piping design, using 1200, as the critical Reynolds number, keeps us on the safe side.

Reynolds number plays an important role in pressure-drop (p-d) calculations. Once we use it to find out whether viscous or turbulent flow exists in a pipe, we can choose the right pressure-loss formula.

When flow is viscous, turbulence entering the stream from any source will be damped out by fluid's viscosity. Since viscosity is the key factor in resistance to flow here, formulas use it, along with flow rate and pipe diameter to figure pressure drop.

If Reynolds number shows that flow is turbulent, viscosity drops out of the picture as a major item in pressure loss. P-d formulas that are OK for Reynolds numbers over 1200 depend on flow rate, density, internal pipe diameter and the friction factor.

We'll talk more about using p-d formulas in a later issue. We bring them up to illustrate the practical importance of finding out whether you're dealing with viscous or turbulent flow.

40

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"Do you take me for a complete idiot, Mr Surfaceblow?" yelled Mr Big, looking a hole right through me

Marmy's Christmas party

► As I LOOKED OVER this morning at Joan McGee, our shapely young blond with the very pleasant smile, there was Christmas in the air, and no mistake about it. This time of year her desk is piled high with those shiny red books, *The Marmaduke Story*. Each mail brings in stacks of orders. Consulting engineers send the books to clients, usually with a Season's Greeting scribbled on the flyleaf. Plant engineers send them to their staff members and advertising agencies send them to their accounts. They cost $1.00 each.

Again I was reminded of Christmas when I looked out our 26th floor window. Snow flurries were blanketing the Hudson River's water front so I could hardly make out the deep-sea ships tied up along the docks. Plowing through the snow after work, I barged into the Bent Propeller Bar, that seafarers' emporium of good cheer and noisy conversation. The place was jammed with burly longshoremen wearing leather windbreakers and Mackinaws, sailors in their pea coats, and merchant ships' officers in khaki work uniforms. White-aproned waiters shoved between the noisy cash customers, swinging steaming trays of Tom & Jerrys, hot rums and glasses of other interesting refreshments over the heads of mariners seated at the tables. And there at one end of the crowded bar was Marmaduke Surfaceblow himself, leaning his towering six-foot four-inch frame heavily on the bar. He was gazing at his favorite beverage, a bottle of Sandpaper Gin.

About the time I found a chair and started thawing out with a hot rum, the old consulting engineer straightened up and, for no good reason that I could see, roared in his foghorn voice, "BILGEWATER on preventive maintenance. I'll tell you jokers about a Christmas I spent ashore that saved the day for a small utility firm."

Everyone quieted down and turned toward our hero. Marmy leaned his back against the bar and gave his old gray bowler a starboard list. Then he hooked his thumbs into the armpits of his checkered vest and blasted away.

"Back in 1900, I was chief service man for a small utility and telephone firm up in northern Ontario," he roared. "In those early days, power plants were crude by today's standards.

"Besides the usual trouble-shooting jobs that kept coming up in that fast-growing community, we had engineering, construction and operating problems. Weekly and biweekly inspections of customers' large installations were thrown into my department, with meter reading and billing for good measure. Last but not least, keeping customers happy was a big part of the service job. So there was never a dull moment in any 24-hour period.

"Problem came up that year on the night before Christmas Eve when most of the big shots and everyone else seemed to be celebrating. Raising hell during the Christmas holidays was the usual thing in that wild country. So urgent service calls were mighty unpopular that evening.

"Headache this time was a principal stockholder of our utility firm. He was one guy that our top brass always handled with kid gloves. To start with, he was a bachelor playboy, who owned a good deal of almost every firm in

(*Continued on page* 190)

MARBLES for MICROBES

Above—100,000X enlargement of latex spheres used to calibrate electron microscope in Nalco Laboratories. Actual diameter of spheres is 0.25 microns—.00000975 inches! *Right*—Inserting specimen holder in vacuum chamber of Nalco electron microscope.

. . . How they assist research toward better Water Treatment

PERHAPS even too small to make good marbles for microbes, these tiny spheres help Nalco Scientists in their investigations of the microscopic realms of matter only recently made visible to the human eye by the electron microscope.

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Nalco WATER TECHS

New reprint of A.S.M.E. Paper No. 52-A-30: *Experimental Studies of Boiler Tube Metal Temperatures: Effect of Heat Transfer Rate and Deposit Thickness*, gives technical data on high-heat-transfer-rate effects (140,000 to 300,000 Btu/sq. ft./hr.) at pressures from 250 to 2500 p.s.i. 16 pages, with tables and diagrams. Author: C. Jacklin, Director, Engineering Research, National Aluminate Corporation.

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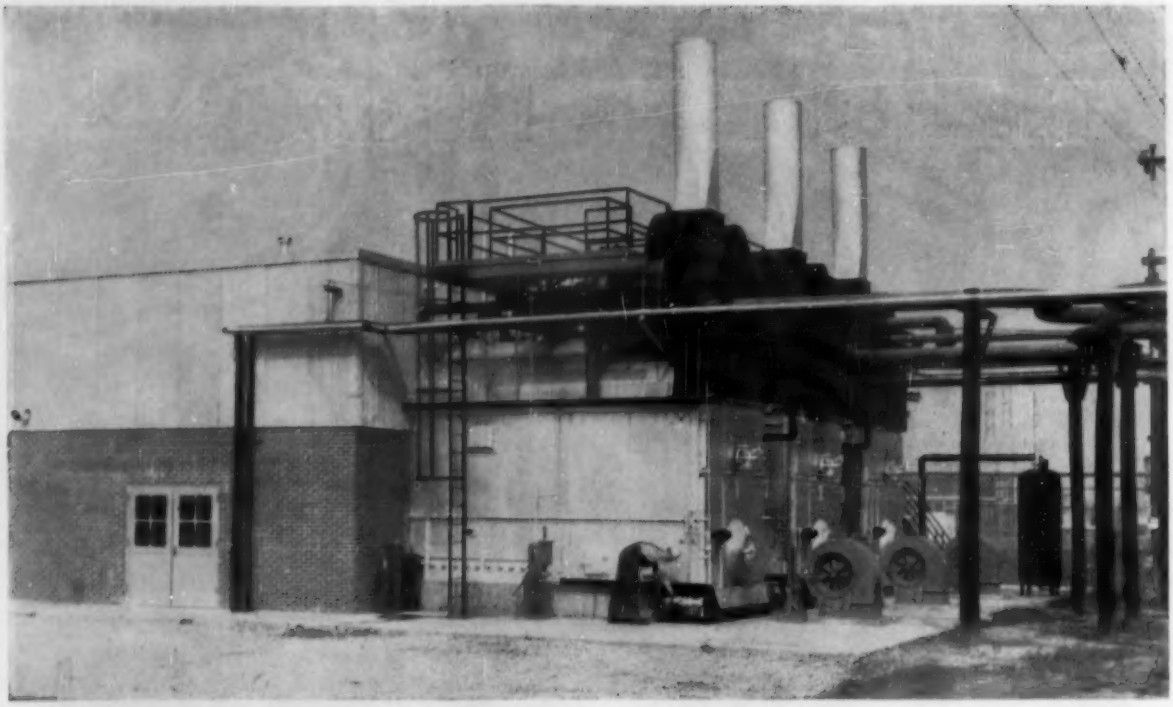


COMBUSTION CONTROLS GO OUTDOORS to help cut steam costs at American Synthetic Rubber Corporation's new packaged boiler plant near Louisville, Kentucky. The three 27,000 lbs./hr. gas or oil fired boilers operating at 175 psi generate steam for heating and processing.

"Big Station" Combustion Controls

Metering-Type Republic Control System Saves Fuel, Enables Boilers to Handle Fast Load Changes Quickly and Smoothly at American Synthetic Rubber Corporation

Peak combustion efficiency plus fast control of widely varying loads—these were combustion control requirements at American Synthetic Rubber Corporation's new packaged boiler plant near Louisville, Kentucky. To meet them, a metering-type combustion control system was specified instead of the "off-on" system usually furnished with packaged boilers. This system contains all of the basic control elements found in large installations and has all of the operating refinements common to large plants.

Is this metering-type control system worth its premium price? Flue gas tests made at various ratings conclusively answer the question with an emphatic YES. Combustion efficiency exceeds what similar packaged installations are delivering — and smoother operation is preventing chain-of-event troubles that frequently are caused by improper boiler operation. American Synthetic expects the controls to pay their extra cost in just a few years through fuel savings alone.

REPUBLIC FLOW METERS CO.

HOW METERING SYSTEM AT AMERICAN SYNTHETIC SAVES FUEL

Unlike most packaged boiler control systems, the Republic Combustion Control System at American Synthetic continuously measures both fuel and air inputs. Changes in fuel pressure, for example, which change the rate of fuel feed are detected immediately and automatically compensated for. Proper fuel-air ratio is maintained automatically at all ratings for maximum combustion efficiency.

Fast load changes are common in the plant with fluctuations varying as much as 8,000 lbs./hr. Rapid control response with Republic's dash-pot stabilization which prevents "hunting" enables boilers to meet new steam demands quickly and smoothly. Steam pressure and draft are held constant even during changing loads by the controls.

CONTROL SYSTEM CHANGES WITH FUEL

On oil firing, the controls operate on a steam flow-air correction system. For safety on gas firing, the controls are transferred to an air flow-gas flow correction arrangement which prevents over-firing in case air to the boilers is limited or blocked for any reason.

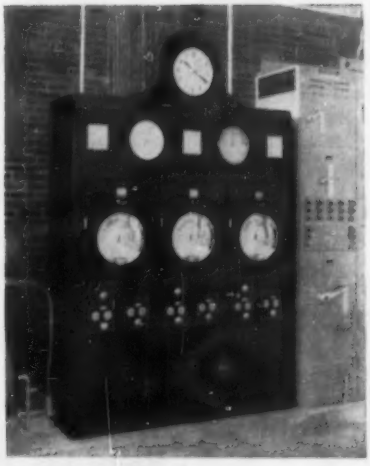
OPERATORS ARE ENTHUSIASTIC

The automatic correction feature of the Republic Controls eliminates time-consuming gas analysis and adjustments which would be necessary periodically with other types of controls. Correct operation of the boilers is easier, surer.

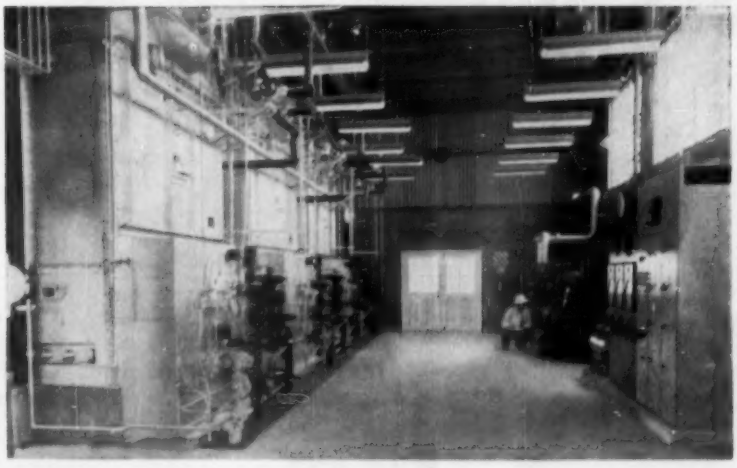
IF YOU ARE PLANNING ON INSTALLING PACKAGED BOILERS, find out how metering-type combustion control by Republic can improve efficiency, cut fuel costs and make operation simpler and easier. Contact your nearest Republic representative.

IF YOU ARE PLANNING *ANY* BOILER PLANT—any size, type or method of fuel firing — you can be sure of maximum efficiency with a Republic Combustion Control System engineered to exactly meet your needs. Write us when your problem is combustion control.

Pay Off for Packaged Boiler Plant



CENTRALIZED instrument and combustion controls on this Republic panel make checking and manual operation convenient and easy.



LOOKS EFFICIENT . . . AND IS. Interior view of the boilerhouse. All three boilers can be operated together or separately by means of control panel at right.

2240 Diversey Parkway • Chicago 47, Illinois

Reader service section

Start with these quick samples . . .

Two more industrial 'firsts' . . .

are reported: City of Larned, Kansas puts a municipal gas-turbine power plant into operation . . . and a plant designed solely for producing synthetic mica formally opens at Caldwell, N. J.

Reports From the Field, p 154

Ready for the kickoff . . .

in a field of 20 technical papers, is the report on "The Philosophy of the V-Engine." Other digests from ASME, AIEE and APC conferences relate to steam plants, gas turbines, electrical equipment, fluid flow – all lined up for your quick review.

Technical Briefs, p 156

New fields are opened . . .

by GE's introduction of an insulation material that makes it possible to fortify organic compounds against high-voltage electrical discharges. First application of this non-tracking butyl product: a 15-kv outdoor instrument transformer.

Plant Equipment News, p 160

"Atom in Our Hands" . . .

is enthralling title of 44-page bulletin that details inside work going on at the Oak Ridge atomic center. To get your copy, check item 34 on convenient post cards.

Free Literature, p 169

What's in an ad?

Times, thinking, products change – yet some companies have deemed it 'good business' to advertise in POWER for the past 71 years. George Edwards turns back the pages of POWER to 1890, reproduces a typical ad page, comments in his sage fashion.

George Edwards' Scrapbook, p 172

Check this section . . .

for other features: Bookshelf, Appointments, Calendar of Events. And there's a guaranteed chuckle in our two cartoons of the month.

For other timely ideas, see following service pages ▶

It's NEW! It's Revolutionary!

Ever see a steam trap

SO SMALL

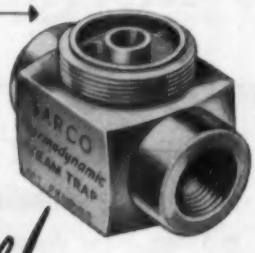
SO SIMPLE

SO TROUBLE-FREE!

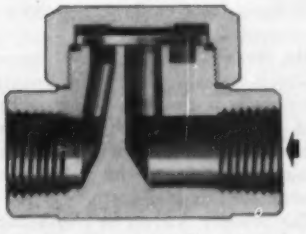
1. A CAP

2. A DISC

3. A BODY



That's all!



YES, SO TROUBLE-FREE: No valve-closing mechanism to wear or stick—the kinetic energy of steam closes valve. No critical clearances to choke. No gaskets to leak.

Practically Eliminates Maintenance!

Here's the *smallest*...the most *compact*...the most *durable* steam trap you've ever seen...for all-around trapping effectiveness! It's the new Sarco Thermodynamic trap.

Look at it. So small...it fits into the hollow of your hand. So simple...only 3 rugged parts...machined from stainless steel bar stock. So trouble-proof...only moving part, a hardened solid stainless steel disc, practically immune to wear. Not affected by superheat, water-hammer, corrosive condensate.

Use the SAME trap for 10-600 psi...for light or heavy loads ...without seat or valve change or other adjustments. Closes tight on no load—no steam waste.

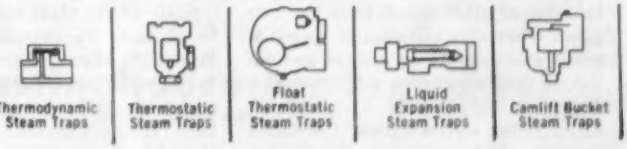
Ask for a 60 day trial installation of Sarco TD trap and strainer...write for bulletin 257. Sarco Company, Inc., Empire State Bldg., New York 1, N. Y.

A140-B

SARCO

Only Sarco Makes All 5 Types

That's why Sarco can give impartial advice on proper steam trap selection.



REPORTS FROM THE FIELD

What's happening in power and what it means to you

For Calendar of Events see page 208

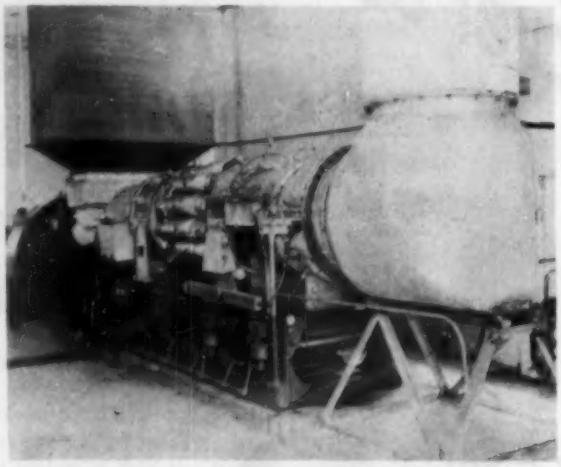
First municipal gas-turbine plant goes into operation

► THE CITY OF LARNED, KANSAS has put into operation America's first municipal gas-turbine power plant. This installation marks a further important step in the use of gas turbines for electric power generation. The 1250-kw unit was supplied by Westinghouse Electric Corp's South Philadelphia plant.

The gas turbine is completely self-contained. It requires no boiler or other external heat source since it burns fuel and converts heat energy into electricity all in a single assembly. The turbine operates at 8750 rpm and is connected to the 1563-kva 1200-rpm generator by a single-reduction double-helical gear.

For full operation, 28,000 cfm of air is drawn in by the axial air compressor and compressed to 53 psig. Fuel is admitted and burned in combustion chambers to heat compressed air to 1250 F. This hot gas expands through the gas turbine, which converts the heat energy into mechanical energy to drive both the axial air compressor and electric generator. The gases are then exhausted to atmosphere at 780 F.

Unit is the simple open-cycle type and is but 35-ft long, 6-ft wide, 6-ft high and weighs only 41,000 lb. It is equipped with a dual-fuel system that allows burning of either natural gas or distillate oil. Either fuel can be used for start-up and a fuel changeover, under load, can be made by manual operation of switches on the control board. This marks the first installation in America of a gas turbine for electric power generation that can changeover, under load, from gaseous to liquid fuel and back again with no effect upon load. The plant can operate without cooling water.



INTERIOR VIEW of the first municipal gas-turbine installation

Niagara Mohawk plant under study in NYU's air-pollution tunnel

► USING TOY-SCALE MODELS of buildings, smokestacks, coal piles and electric transmission towers, New York University research engineers have begun an air-pollution study of Niagara Mohawk Power Corporation's Huntley Station in Tonowanda, N. Y.

The company plans to replace a section of its present boiler plant. To determine height and design of a single tall smokestack that will supplant two existing short (207 ft) stacks, University engineers are examining downwash behavior of stack gases from the new plant. They also will suggest speeds at which gases should be ejected and advise on use of nozzles on the stacks. An additional 200,000 kw is being added to the station's present installed capacity which amounts to 801,000 kw.

Tests are being conducted in NYU's air-pollution wind tunnel—only one of its kind. One wall of the 30-ft tunnel is made of glass to permit observation. A propeller at one end sucks air through the tunnel to simulate wind. Engineers "change the direction" of the wind by rotating the model on a turntable.

Smoke is generated and sent through miniature stacks on the model. In the Niagara Mohawk study helium is added to the smoke to duplicate buoyancy of exhausts existing in the actual plant operation—caused by gases being exhausted at temperatures from 200 to 300 F.

Scale of the plant model is one inch to 30 feet. To reproduce all factors that might effect dispersal of stack exhaust, such surrounding features as coal piles, coal conveyors, transmission lines and switchyard have been included in the model.

Dedicate world's first plant for producing synthetic mica

► A NEW PLANT designed solely for producing synthetic mica has formally been opened. This marks the successful conclusion of a 10-year effort to produce mica synthetically, and reduce U. S. dependence on foreign sources for the material.

The synthetic mica is made from raw materials—plentiful in this country. Not only is it a substitute for natural mica, but, in many cases, particularly where extremely high temperatures are encountered, it may be used where natural mica is ineffective.

The product, known as *Synthamica*, is produced by the Synthetic Mica Corp, Caldwell Township, N. J., a subsidiary of Mycalex Corp of America.

The company announces an expanded

(*Continued on page* 202)

New Money-Saving Airpower Anywhere in the Plant

Compact... Lightweight... Air Cooled

Le Roi Stationary Compressors are easily installed... anywhere

Take full advantage of every space in your plant where the economies of airpower can increase production and lower costs. How? By using Le Roi's two-stage, air-cooled stationary compressors that require a minimum of space, and are easy to install.

They're compact and lightweight. Moreover, these Le Roi compressors require no cooling water, eliminating the need for expensive space-eating pipes. There's no danger of freeze-ups or overheating from lack of liquid coolants. Only minimum attention by an operator is needed.

The new three cylinder 50S2, and six cylinder 75S2 and 100S2 compressors are balance-designed, reducing vibration and noise to a minimum. Available in 50, 75, and 100-hp sizes producing 210, 340, and 450-cfm capacities at 125 lbs. pressure, these new Le Roi airpower units offer low-cost operation, low-cost installation, and low-cost maintenance advantages for a wide range of needs.

For years Westinghouse compressors were the national favorite in the ½ to 40-hp size range. With the three new Le Roi sizes, an even greater range of dependable airpower is yours — up to 100 hp.

Write today for complete literature describing Le Roi's dependable, low-cost air supply.

LE ROI Division of Westinghouse Air Brake Co.

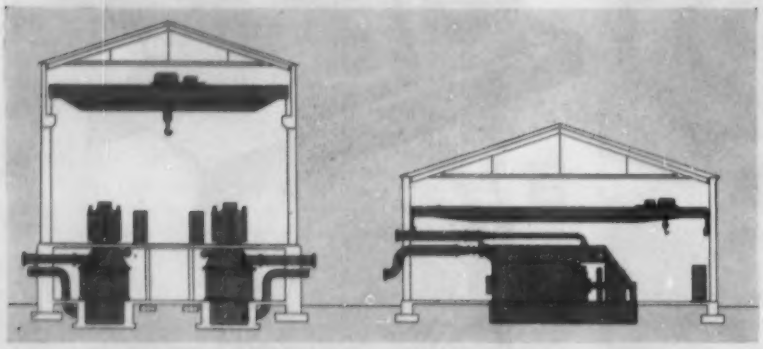
MILWAUKEE 1, WISCONSIN

Distributors in all principal cities

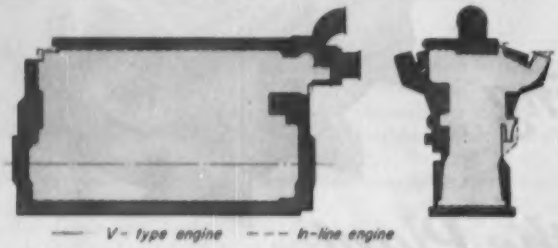
TECHNICAL BRIEFS

Latest engineering developments for busy power men

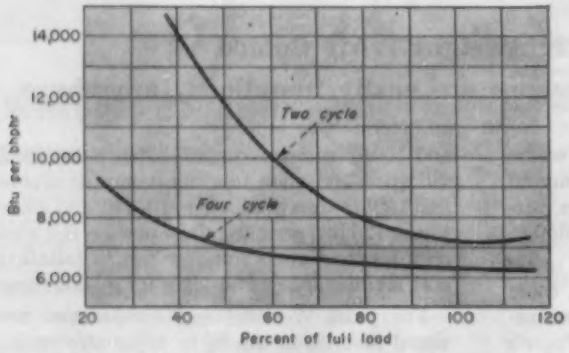
20 Papers for you on:
STEAM PLANTS
GAS TURBINES
ELECTRICAL EQUIPMENT
FLUID FLOW



1 Cross sections of typical vertical-shaft X-type and V-type engine installations



2 Outlines of V- and in-line engines of same bore and stroke



3 Fuel-consumption rates—spark-ignited natural-gas engines

Modern V-engines prove their worth in use

The philosophy of the V-engine. *By R L Boyer and J W Holmes, The Cooper-Bessemer Corporation.*

During recent years progress of the internal-combustion engine has been in the direction of higher unit output with increased economy. Rise in the popularity of the V-engine has been a significant part of this development. Although many other cylinder configurations have been conceived with these objectives in mind, the V-engine has demonstrated superiority in mechanical design, ease of maintenance, and space requirements.

Fig. 2 shows comparative sizes of an in-line engine and a V-engine. Significant reductions have also been made in engine weight and foundation requirements per horsepower. Most of the normally serviced individual components or assemblies are no heavier than for the in-line engine and thus may be handled just as easily during maintenance. Also, the V-engine retains almost completely the accessibility of the in-line engine.

Specific fuel consumption as a function of percent full load is shown in Fig. 3 for both 2- and 4-cycle spark-ignited natural-gas engines. The 2-cycle engine is a V-type compressor unit thought to represent the best performance of this type commercially available today. The 4-cycle curve was obtained from a large stationary V-type unit.

Fig. 1 contrasts the space requirements of X-type vertical-shaft engines and the V-type engine. It is concluded that the V-engine affords a large increase in engine displacement with modest space requirements, and paves the way for the advance to higher mean effective pressures. *ASME paper No. 55-OGP-7.*

Steam plants

Accelerated loading of large high-pressure, high-temperature turbine-generators. *By W C Beattie, J M Driscoll, and M Salvage, Consolidated Edison Company of New York, Inc.*

With the advent of large capacity turbines operating at high pressure and temperature, present low rates of loading require hours to bring these units to their full capacities. This paper discusses the results of high rates of loading tests conducted while independently heating horizontal flanges and bolts of turbine cylinders by admitting live steam under controlled pressure to the annular space surrounding the horizontal flange bolts. It shows how existing loading rates can be increased sixfold with a simultaneous reduction in cylinder flange and bolt stresses.

The authors offer the following conclusions from the results of the starting

47 miles of Johns-Manville 85% Magnesia Insulation boosts operating efficiency of Plant Hammond, one of the South's largest and most modern private utility installations.

Insulating feed water line at Plant Hammond. Contractor for this job was Brooks-Fisher Insulating Company of Atlanta, Georgia.

J-M 85% Magnesia Insulation helps cut fuel rate 25% below national average

Officials of the Georgia Power Company were gratified when the coal rate of their new Plant Hammond worked out at 0.75 lb. per KW HR, 25% below the national average. In their annual *Electrical Industry Statistics*, *Electrical World* had reported that increased efficiency in the techniques of power production has lowered the average coal rate to 1 lb. per KW HR. in 1954.

An important factor contributing to Plant Hammond's high efficiency was the selection of insulation. Johns-Manville's 85% Magnesia was applied in the most economical thicknesses throughout the plant for all piping and equipment operating in its temperature range. At higher temperatures 85% Magnesia was used in combination with J-M Superex® diatomaceous silica insulation.

This is only one of thousands of case histories where J-M 85% Magnesia has helped industry achieve outstanding fuel savings and increased operating efficiency. In all types of manufacturing and processing plants it is the standard for temperatures to 600F . . . providing high insulating value, easy application, long life, initial low cost and minimum maintenance. Write today for further information on J-M 85% Magnesia and Johns-Manville's complete drawing-board-to-job-site insulation service. Address Johns-Manville, Box 60, New York 16, New York. In Canada, Port Credit, Ontario.

Johns-Manville *first-in* INSULATION

MATERIALS · ENGINEERING · APPLICATION

More TECHNICAL BRIEFS

Begins on page 156

and loading tests on single- and double-shell high-pressure high-temperature turbines: (1) To avoid overstressing of horizontal flanges and bolts during the loading period of a start made after a weekend shutdown, the permissible rate of maximum loading has to be kept so low that it is neither reasonable nor practical, especially for large capacity units. (2) To permit a reasonable rate of loading following a weekend shutdown, it is necessary, in order to avoid overstressing of flanges and bolts and to keep spindle and cylinder differential expansion within limit, to heat the cylinder horizontal flanges and bolts independently, in addition to the heat conducted from within the cylinder.

(3) To avoid overstressing of horizontal flanges and bolts during the loading period following a 15-minute start after an overnight shutdown, the loading rate should be kept below one megowatt per minute. (4) By heating the flanges and bolts independently during the loading period following a 15-minute start after an overnight shut-down, it is possible to increase the loading rates to 3 or more megawatts per minute. *ASME paper No. 55-SA-63.*

A comprehensive training program for power plant personnel. *By Harold Grasse, Black & Veatch.*

This paper describes an extensive training program for power-plant operators and includes its organization, the preparation of operating instructions, and the methods used to teach the subjects in the classroom and during start-up. Operators having limited experience in existing stations were trained in eight months to operate a new power plant. Their level of proficiency after this training was equivalent to, and perhaps greater than, that which they might have attained only after several years of operating experience. *ASME paper No. 55-SA-41.*

Gas turbines

The aerothermopressor—a device for improving the performance of a gas-turbine power plant. *By A M Shapiro, K R Wadleigh, B D Gavril, and A A Fowle, Massachusetts Institute of Technology.*

The purpose of this paper is to present both an introduction and a progress report on a novel aerothermodynamic device which performs the function of a compressor but which requires only an extremely simple mechanical structure having no moving parts. Basically, the aerothermopressor is a duct within which atomized water evaporates into a high-speed stream of high-temperature gas, thereby inducing a rise in isentropic stagnation pressure of the gas stream. One of the most attractive applications of the aerothermopressor is as an auxiliary for improving the performance of a gas turbine plant.

Directions for ordering papers on p 238

The plan of the paper is (1) to develop the basic ideas and the theory of the aerothermopressor, (2) to illustrate its application to the gas-turbine plant, (3) to discuss the factors entering into the design of an aerothermopressor and the considerations for handling them, (4) to present the theoretical and experimental results thus far obtained, and (5) to evaluate the future prospects of the aerothermopressor and name the crucial problems which it faces.

Conclusions reached are: (1) The wide variety of gas dynamics phenomena observable within the aerothermopressor are explainable in terms of heat transfer, evaporation, droplet drag, wall friction, and cross-sectional area variation. (2) Experiment and theory both show that the aerothermopressor can produce a net rise in stagnation pressure with mass flows of about 2 lb per sec or greater. (3) A net rise in stagnation pressure has already been won in a 26 lb per sec unit, and in this size the theory suggests that rises of perhaps 20% are achievable. The latter figure would lead to improvements in both fuel economy and power capacity of a simple gas-turbine plant of about 20%.

(4) The theoretical analysis of the aerothermopressor gives a generally correct picture of its performance. (5) With high subsonic Mach Numbers at the inlet, the required length of evaporation section is about 5 feet, and for an initial stagnation temperature of 1500 R, the optimum water-air ratio is in the neighborhood of 0.25. *ASME paper No. 55-SA-65.*

Some aerodynamic investigations in centrifugal impellers. *By J T Hamrick, National Advisory Committee for Aeronautics.*

Results of both theoretical and experimental investigations of flow in rotating impeller passages are presented in this paper. It is the purpose of the presentation to acquaint the designer with the manner in which losses arise, their effect upon the flow within the passage, and their over-all effect upon impeller performance. In addition, analysis and design methods based on isentropic flow calculations are discussed and their application to the design of mixed-flow impellers is demonstrated. *ASME paper No. 55-SA-53.*

Electrical equipment

A new 500-mva air magnetic circuit breaker of simplified design. *By M J Reilly and D E Weston, Allis-Chalmers Mfg Company.*

The air magnetic power circuit breaker is a relatively new development in the field of circuit protection. Although the principles involved have been well known for many years, power circuit breakers making effective use of this knowledge did not become commercially available until comparatively recent years. Since then they have become almost universally accepted and now enjoy a very prominent position among the various types of circuit breakers.

Magnetic circuit breakers find their greatest use on electric circuits of 13.8 kv and below, and provide interrupting capacities up to 500 mva. There is little doubt, however, that these limits will be extended in the near future, particularly as regards interrupting capacity.

The air magnetic power circuit breaker has played an important role in making possible modern completely enclosed metal-clad switchgear with all its advantages of safety, convenience, low cost, ease of installation, pleasing appearance, and simple, inexpensive maintenance. When used with metal-clad switchgear, the magnetic circuit breaker is in the form of an easily removable unit which can be conveniently removed from the cubicle for inspection or maintenance, or to substitute a spare unit. The ease of accessibility of all parts of the magnetic circuit breaker makes it particularly suited to a program of maintenance with a minimum of time out of service.

Inasmuch as the modern circuit breaker is so widely applied in many and varied industrial requirements, and considering the costliness of power outages and the expense of time-consuming maintenance, it is important that a design program for such a circuit

(*Continued on page* 226)

Regulex VOLTAGE REGULATORS

when loads are light

Keep Generators Stable

When the city sleeps, power demands are light. As the load drops, high power factor operation may cause generator instability.

Why *Regulex* Control?

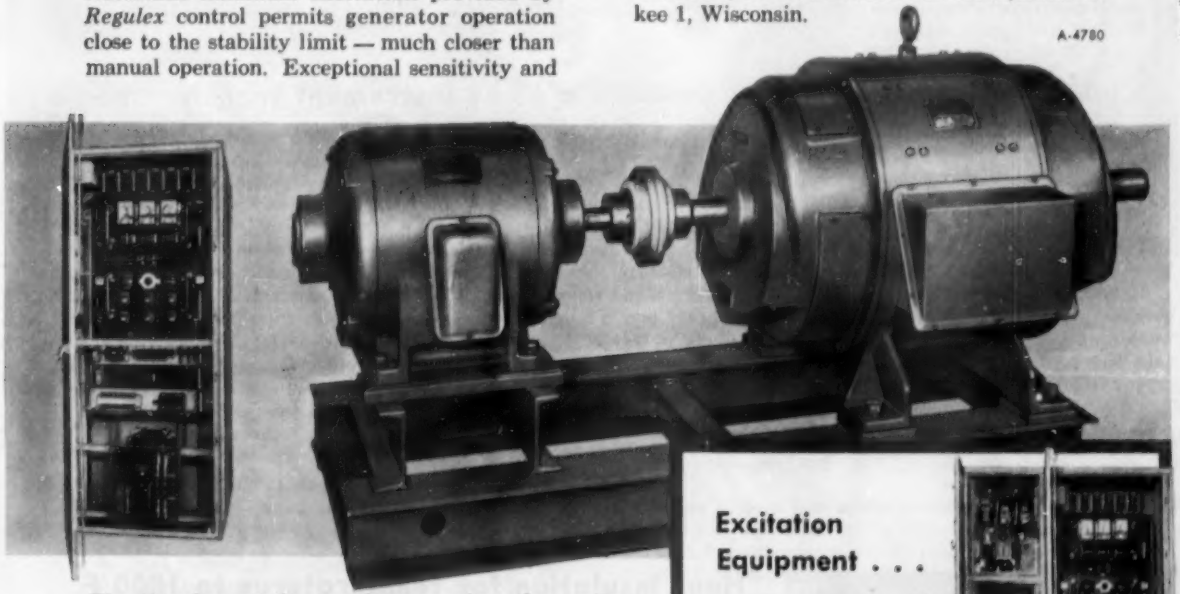
Conventional voltage regulators in power plants cut down excitation, but do not promote stability. *Regulex* control recognizes the stability problem and does not reduce excitation below the stable value.

How It Works

Automatic minimum excitation provided by *Regulex* control permits generator operation close to the stability limit — much closer than manual operation. Exceptional sensitivity and rapid response of the *Regulex* regulator and associated equipment establish and maintain a safe ratio between generator load and field current. As a result, operating limits are broadened at any power factor loading . . . proper reactive kva division is assured.

In power plant applications, *Regulex* voltage regulators may be used with alternators or synchronous condensers. No multiple special fields are required in the exciter. Get all the facts. See your A-C representative or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

A-4780



The *Regulex* rotating regulator consists of a motor-generator set and a cubicle containing the static regulator element. The cubicle may be installed in any convenient spot or combined with switchgear equipment. Because there are no moving parts in the static regulator element, adjustment and maintenance are eliminated.

Excitation Equipment . . .

consists of main and spare exciter field breakers in a lineup with static equipment.

Regulex is an Allis-Chalmers trademark.

A-C ALLIS CHALMERS

ALLIS-CHALMERS

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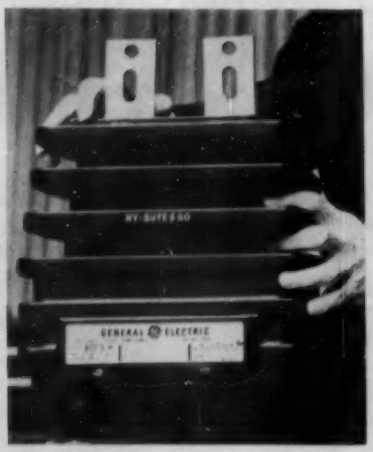
PLANT EQUIPMENT NEWS

Your information center for new products designed to solve plant problems

Published monthly as a service to readers

HIGH-VOLTAGE TEST is run on new insulation material. After numerous surges it was found free of carbon-tracking



FIRST APPLICATION of non-tracking butyl insulation, *Hy-Bute/60*, will be a 15-kv outdoor instrument transformer

CURRENT TRANSFORMER, with *Hy-Bute/60* insulation, survived a 1400 hr test at full voltage in salt-fog chamber

Insulation material makes possible a 15-kv instrument transformer

1207 • New insulation material is claimed to make it possible to fortify organic compounds against high-voltage electrical discharges. First application of this discovery will be in the form of reinforced butyl, *Hy-Bute/60*, from which high-voltage outdoor instrument transformers will be molded.

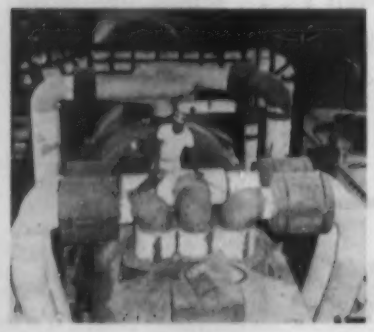
According to manufacturer, *Hy-Bute/60* incorporates a chemical mechanism, built into the butyl rubber, that prevents formation of free carbon. This prevents formation of a carbon track and the consequent failure that occurs if organic components of the insulation break down.

E E Parker, General Manager of GE's Instrument Department, states, "Successful development of non-tracking *Hy-Bute/60* has made possible construction of instrument transformers for outdoor applications at 15 kv and above, under most severe atmospheric conditions. Elimination of oil-filled metal casings, porcelain bushings and gaskets means smaller, lighter transformers that virtually eliminate maintenance and susceptibiity to mechanical damage. In addition, there can be no explosion or fire hazard."

Numerous tests in cooperation with several public utilities and in the laboratory have demonstrated the ability of *Hy-Bute/60* to withstand the most severe atmospheric conditions, including salt fog and spray in seacoast locations.

General Electric Company, Schenectady 5, N. Y.

For more data on these items, use post cards page 169. Identify your request with item number.



Heat insulation for temperatures to 1800 F

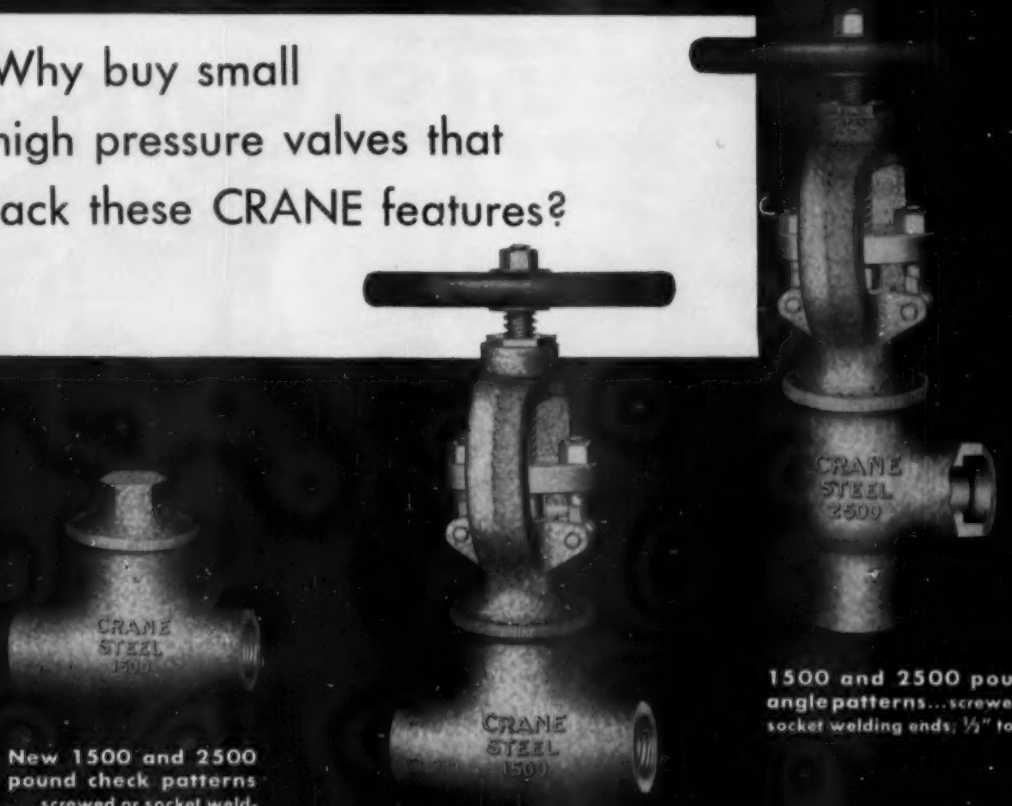
1208 • *Kaylo-20* heat insulation is designed to withstand temperatures of 1800 F. A hydrous-calcium-silicate product, it is used primarily as covering for pipes and vessels. It has the unique advantage of expanding slightly up to 1100 F. Completely immersed in a test furnace at 1800 F shrinkage is limited to about 1½ per cent, according to the manufacturer. The material approaches refractory range — meets requirements of chemical, power, petroleum industries where high temperatures occur.

Pipe insulation is produced in thicknesses and diameters for pipe sizes from ½ to 39 in. Outside diameters correspond to those of standard pipes, permitting nesting when necessary.

Block insulation is made 36 in. long, in standard widths to 18 in., and thicknesses to three inches.

Owens-Illinois Glass Co, Toledo, Ohio

Why buy small high pressure valves that lack these CRANE features?



New 1500 and 2500 pound check patterns . . . screwed or socket welding ends; ½" to 2". Patented construction assures high disc lift, free flow and minimum pressure drop.

1500 and 2500 pound globe patterns... screwed or socket welding ends, ½" to 2".

1500 and 2500 pound angle patterns... screwed or socket welding ends; ½" to 2".

When you buy CRANE Lip-Seal Bonnet Valves . . . designed exclusively for high pressure/high temperature power plant service . . . you are assured of:

- lip-seal welds that are laid on flat surfaces—needn't be chipped out or burned out;
- easy dismantling and reassembly—bonnet screws out after weld is *ground away*—makes inside of valves entirely accessible;
- bonnet threads are chrome plated to prevent galling or seizing;
- stems that do not bind or gall—because of CRANE's exclusive ball-joint glands;
- easy access to stuffing box—swing-type gland eye-bolts swing free of yoke area, can't be lost;
- a more rigid swivel disc-stem connection that minimizes vibration;
- each size valve is a separate design for proper proportion—another CRANE exclusive.

Specify "Crane Lip-Seal" when you want small valves for high pressure/high temperature steam service. For more reasons why you should do so, ask your CRANE representative for Circular AD1902, or write direct. CRANE CO., General Offices: 836 S. Michigan Ave., Chicago 5, Ill. Branches and Wholesalers Serving All Industrial Areas.

CRANE CO.

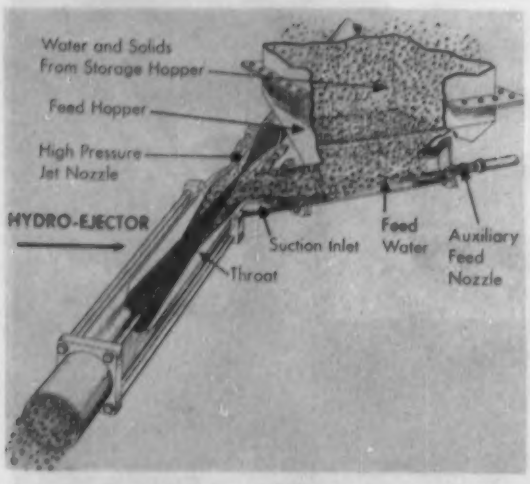
for the THRIFTY BUYER

VALVES • FITTINGS • PIPE
KITCHENS • PLUMBING • HEATING

CRANE'S FIRST CENTURY...1855-1955

More EQUIPMENT NEWS

Begins on page 160



Jet pumps transport solids through pipelines

1216 • *Hydro-Ejector* jet pumps are available in four sizes, for 4, 6, 8 and 10-in. transport pipelines. Because jet nozzle tip is located out of path of materials being handled, it cannot interfere with free flow of solids, manufacturer states.

Unit is installed with water-tight housing with access door, observation window and emergency flow connection that encloses feed hopper and discharge opening of storage hopper. This design feature is claimed to prevent flooding of operating floor during over-feeding or when draining flooded-type storage hoppers. Iron pyrites can be transported in same system that conveys bottom ash or furnace slag. Unit can be equipped with special gaskets to withstand effects of acids, alkalis and high temperatures. Further data on request to manufacturer.

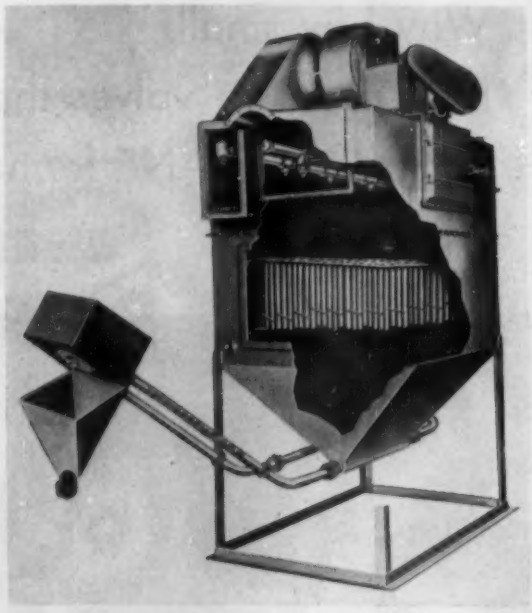
The Allen-Sherman-Hoff Company,
239 E Lancaster Ave, Wynnewood, Pa.

Fire truck line designed for in-plant duty

1217 • Designed to carry a wide assortment of fire-fighting equipment, these trucks are especially adaptable to needs of plant fire brigades. Six basic models are available.

The *KB 8 Model*, featuring a 300-lb dry chemical unit backed up by a 150-gal. water fog system, is expected to find widest industrial use, according to company officials. Other units utilize dry chemical-carbon dioxide combinations, water fog-carbon dioxide combinations or solely water, depending on types of hazards to be protected. Units are offered on 3-wheeled 42-in. wide, or 4-wheeled 48-in. wide, chassis.

Ansul Chemical Company, Marinette, Wis.



Scrubber removes impurities at 99% efficiency

1215 • Dust control unit is claimed to remove microscopic solids, fumes and odors from exhaust gases at 99% efficiency. It can be used anywhere impurities are encountered of extremely low and even sub-micron size particles.

Unit collects dust by hydro-compressing exhaust gases through a system of multiple tubes into a water chamber. This produces a highly efficient scrubbing action. The violent water agitation set up causes a secondary pressure turbulence and additional scrubbing action in the tube chamber.

The scrubber comes in 15 sizes for capacities ranging between 500 and 40,000 cfm. Sludge can be removed constantly or intermittently by manual, hydraulic or mechanical means.

Dust-laden gases can be pre-wetted and pre-cooled in plenum or entry chamber. This, plus constant recirculation of water, makes it possible to operate scrubber at high temperatures.

Constant flushing of interior is said to prevent build-up of solids on internal surfaces and components. There are no moving parts to maintain or replace.

Manufacturer states that the water consumption is low because unit operates on recirculating system—makeup water is controlled automatically. Any unit in the series can be installed either indoors or outside.

The Johnson-March Corp, Philadelphia 3, Pa.

Device combats backwash difficulties

1218 • This innovation, a sub-surface washer, is designed for use with demineralizers, zeolite softeners and filters experiencing excess fouling of beds.

It is used to combat (1) dense precipitates that must be broken into finer particles for removal by normal backwashing rates (2) sticky precipitates that cause filter and ion-exchange particles to form large lumps—short circuiting backwash water (3) fibrous materials that form a matting on surface of the bed. Further information on request to manufacturer.

Graver Water Conditioning Company,
216 W 14th St, New York 11, N. Y.

To obtain more information on these new equipment items, use post cards on page 169. Identify your request with item number.

THIS SPECIAL TYPE OF SEALING AND GASKETING MATERIAL
WILL HELP YOU SOLVE MANY GASKETING PROBLEMS . . .

Ankorite

PROCESSED FELT GASKETING AND TAPES

Can be furnished in 36" widths or in strip form in rolls.

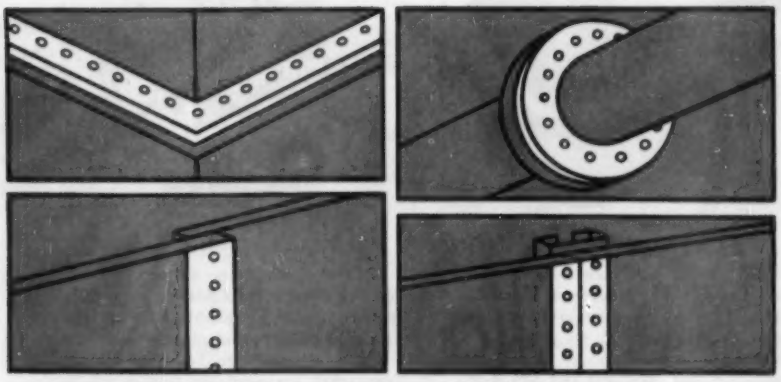
Wherever corrosion, moisture, mildew, fungus, vibration, dirt or grit sealing problems face you, they will be quickly and easily solved by Ankorite Impregnated Wool Felts. Ankorite is your surest way to smooth, economical operation.

For its all-out resistance to weather elements and wear and tear and long life, Ankorite *can't be beat.*

There are many plain and adhesive-backed types of Ankorite from which to choose: Each is heat-sensitive and easy to apply regardless of the position — vertical, horizontal or overhead.

Illustrated below are some of its uses. There are many others.

Since Ankorite is so widely used by industry, we think you might have an immediate use for it. So, for detailed information showing how Ankorite might help solve your sealing and gasketing problems, we invite you to write today for special literature.



For angle flanges—lapped—round or irregular-butted.

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THE ANCHOR PACKING COMPANY

GENERAL OFFICES: PHILADELPHIA, PA.
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FIBROUS AND METALLIC PACKINGS FOR EVERY INDUSTRIAL PURPOSE

More EQUIPMENT NEWS

Begins on page 160

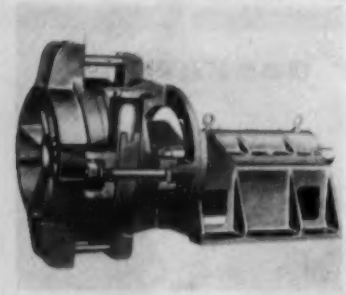
Three products aimed at solving today's pumping problems

Rubber impeller pumps

1209 • Series of Neoprene-rubber impeller pumps from ⅜ to 1¼-in. ips have flow ranges to 55 gpm. They are intended for use where a low-pressure, low-cost pump is required to transfer any liquid that does not affect bronze or Neoprene, with pressure range to 30 psi, depending upon model.

Pump operates in either direction and is self-priming to about 15-20 ft when wet. Speeds range from 100 rpm to a maximum of 1750.

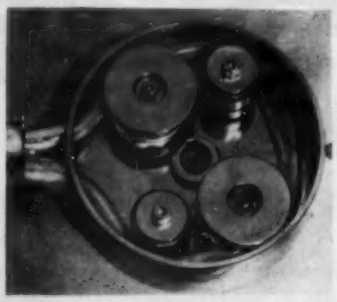
American Machine Products, Inc, 172 Centre St, New York 13, N. Y.



Heavy-duty slurry pump

1210 • *Type RX* unit is a low-speed, continuous-duty pump available in seven different models from 2 to 6-in. size. It is designed to handle abrasive slurries, chemical sludges, plant wastes and other products up to maximum fluid consistency under suction lift of positive head. Features claimed include a stuffing box that is subject to suction pressure only; wearing parts that can be reached without disturbing piping; adjustable rotating element.

Morris Machine Works, Baldwinsville, N. Y.

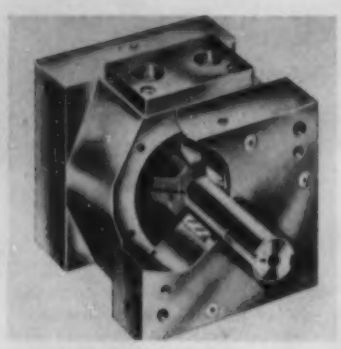


Low-cost hose pump

1211 • Unit pumps either air or liquids, is suitable for a variety of industrial uses. Operation is simple. Two small cylinders, mounted in a larger cylinder, are connected to motor shaft. As motor turns, cylinders spin—their surfaces rolling against wall of larger cylinder. A plastic hose extends from larger cylinder—loops interior of cylinder wall. As small cylinders spin they push against hose, pull in, then push out air or liquid. Request details.

The Jerome Murray Corp, 401 E 58th St, New York, N. Y.

Three items for modern mechanical-transmission applications



Oscillating torque motor

1212 • Unit is said to be capable of obtaining up to 280 deg rotation of a shaft for purpose of turning, opening, closing, clamping, indexing, feeding, etc. It eliminates linkage, gearing, transmissions, cylinders, cams and is claimed to operate on air, oil, water or fire-resistant fluid pressure mediums. Unit is recommended for operating pressures from 0 to 1500 psi.

Roto-Mation Motors, Inc, 525 S Riverside, St Clair, Mich.

Magnetic disk brake

1213 • Magnetic brake is for use in the 50 to 100-hp range. Design improvements are said to have reduced brake dimensions with no decrease in torque rating. Four torque ratings are available: 230, 345, 460 and 575 lb-ft. Unit may be supplied for motor or floor mounting and may be arranged to operate on either ac or dc. Further details on request to manufacturer.

Stearns Magnetic, Inc, Milwaukee 46, Wis.

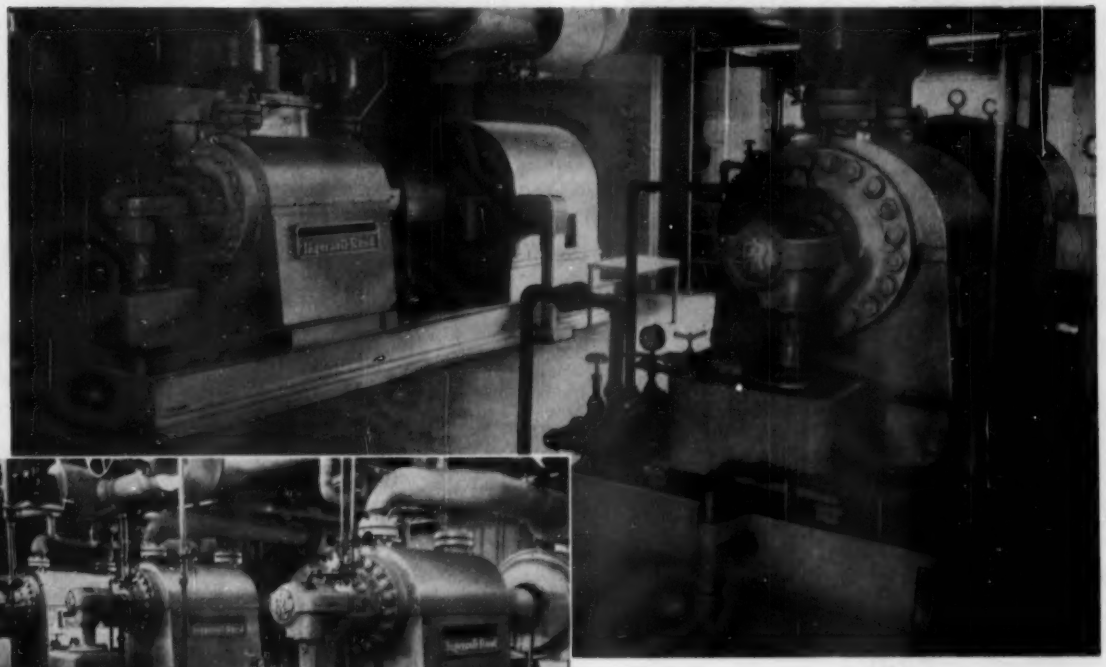
Flexible chain coupling

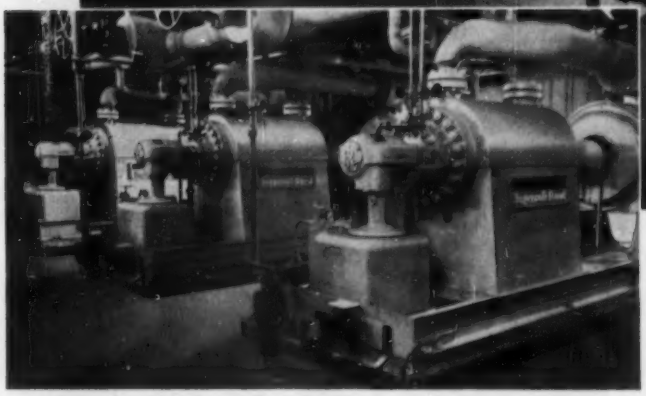
1214 • Flexible-type units permit sufficient relative movement between hubs to accommodate slight angular and parallel shaft misalignments. Among features claimed are *Taper-Lock* bushings that are available from stock in desired sizes—no reboring is required. Chain is double width, made to conform to ASA specs. Additional bearing area permits higher hp ratings.

Dodge Manufacturing Corp, Mishawaka, Ind.

For more data on these items, use post cards page 169. Identify your request with item number.

8 I-R BOILER FEED PUMPS serve large Southwest utility





... and 3 MORE are on order!

ONE good pump deserves another. And so it grows—the record of repeat orders for I-R pumps.

Here, for example, is a large Southwest utility where the consulting engineers specified and installed *eight* Ingersoll-Rand "double-case" boiler feed pumps and ordered three more—all within a four year period. What better proof of satisfactory on-the-job-performance!

The first three CHTB pumps, shown in the smaller photo and installed in 1949, are 7-stage units rated 537 gpm at 929 psig serving two 18,750 kw generating units. The two additional CHTBs illustrated, installed in 1951, are each rated 1090 gpm, 906 psig, supplying 50,000 kw of generating capacity. At another plant in this utility's system, three I-R boiler feed pumps, rated at 1440 psig, are installed on the present 100,000 kw unit and three more are on order for a 156,000 kw addition planned. They will be rated 1545 gpm, 1918 psig.

When it comes to high pressure boiler feed—or any *other* power plant pumping problem — make sure of service-proved performance by specifying Ingersoll-Rand. Your I-R representative will be glad to serve you in any way.

10-103

Ingersoll-Rand

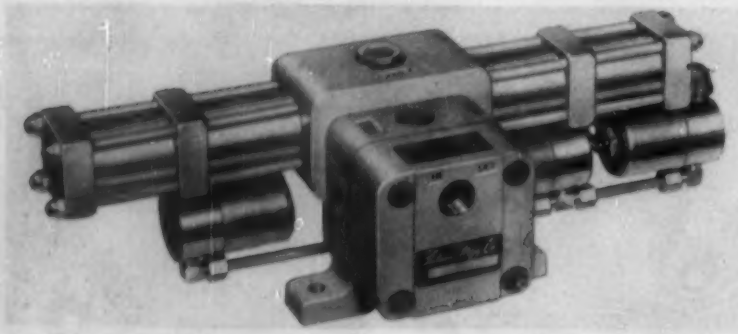
CAMERON PUMP DIVISION
11 BROADWAY, NEW YORK 4, N. Y.

COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO-BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • DIESEL AND GAS ENGINES

More EQUIPMENT NEWS

Begins on page 160

Three valves for varied power needs

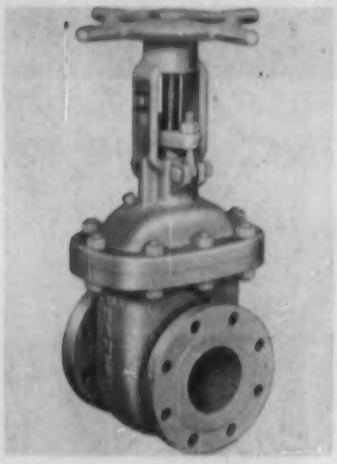


Valve features power operation to forward, reverse, neutral

1201 • *Model PON* is a standard 4-way disk valve for air, gas, oil or water service—controlled by a 3-position power attachment operated by air or gas. It is designed for remote control and automatic operation.

Rotating disk construction, a molybdenum alloyed semi-steel body and chrome-plated face in body are features claimed by the manufacturer. Integral disk and stem are said to provide maximum rigidity and durability. Body and disk are lapped to optical accuracy for perfect seal. Request bulletin 1010 for further information.

Ledeen Manufacturing Co, 1600 S San Pedro St, Los Angeles 15, Calif.



Gate valve has *Teflon* seals

1202 • New gate valve provides impenetrable line shutoff, both on upstream and downstream side of the wedge. In addition to precision metal-to-metal contact of wedge and valve body seats, unit incorporates a pair of *Teflon* packing seals that press dead-tight against the wedge. Stainless-steel locking rings and seats make the valve impervious to corrosive fluids moving through the line. Replacable stainless-steel seat is lightly welded into valve body to insure against leak through. Valve is easily serviced in the line if necessary.

Hamer Valves, Inc, Box 1851, Long Beach 1, Calif.

Diaphragm control valve

1203 • *Bantam* bellows sealed diaphragm control valve is designed for leakproof control of hazardous process flows. Photo above shows unit with special flange facing to receive ½ in., 150 lb ASA raised-face flange. Stainless-steel is used throughout body and bonnet assembly. Any available barstock material may be used. Maximum diaphragm pressure is 100 psig.

Bellows rating is 500 psig at from –70 to 700 F. Air cooling fins or extended neck bonnets may be supplied. Further data on request to the manufacturer.

George W Dahl Co, Inc, 430 High St, Bristol, R. I.

New service protector has high interrupting capacity

1204 • Service protector with interrupting rating up to 200,000 amps is designed for service entrance or feeder duty. It is available in four ratings: 1600, 2300, 3000 and 3500 amps at 480 volts ac, 60 cycles, with G-E *type CLF* fuses. These ratings include the fuses—no further de-rating is necessary. It is supplied with an enclosing case or without case for installation on a switchboard. Provision is made for connection either to bus or cable.

General Electric Co, Schenectady 5, N. Y.

Current-limiting reactors

1205 • These reactors are used to limit short-circuit current to safe values and to reduce effect of resulting voltage disturbance. Unit has cable-support columns built of polyester-glass-resin cleats and epoxy-resin tie rods to provide high compressive and tensile strength.

Reactors are designed for indoor or outdoor service in single or three-phase ratings from 5 to 6000 kva; 300 to 6000 amps; and 1201 to 34,500 volts.

Wedge-shaped cleat used in reactor column has a high dielectric value, and its resiliency to thermal and mechanical shock is said to practically eliminate aging and maintenance problems. Wedge shape assures proper cooling under all conditions by increasing radiating surface on the inside turns and provides additional mechanical strength by making shorter unsupported spans of cable on the outside turns.

Westinghouse Electric Corp, Box 2099, Pittsburgh, Pa.

Electric generating plant

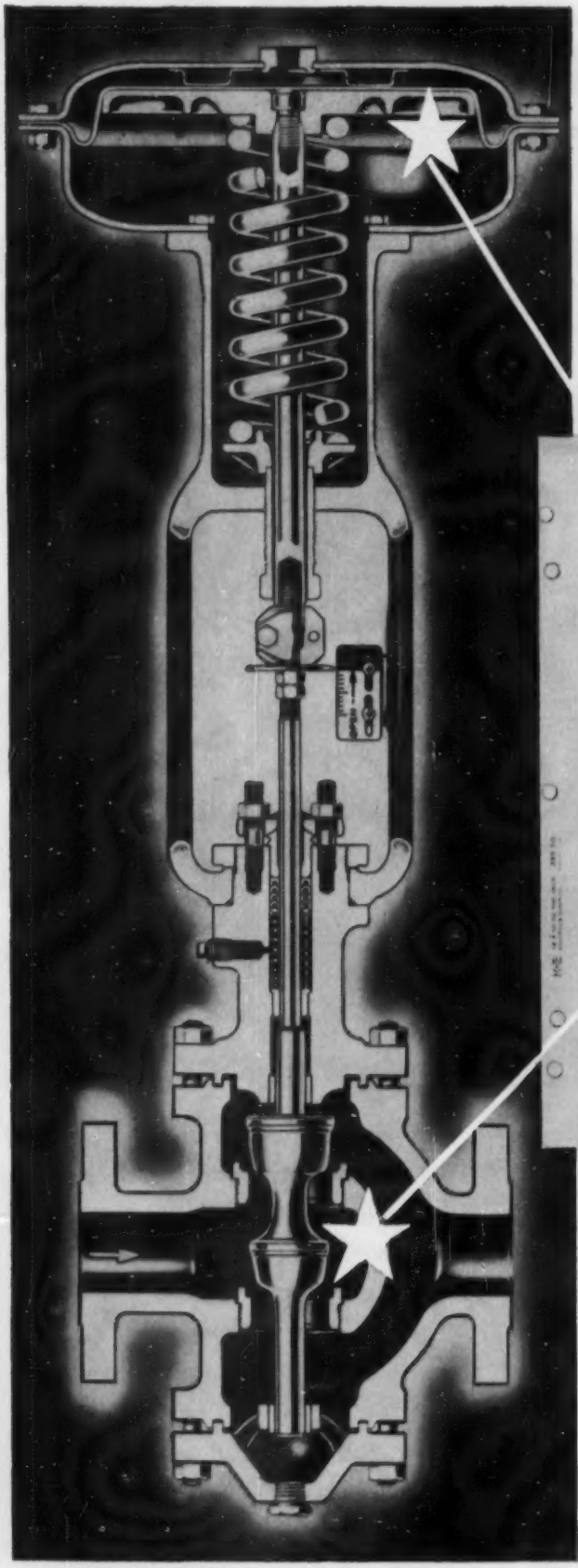
1206 • *Model 2 LK* produces 2000 w, 60-cycle ac at 1800 rpm (or 1500 w in 50 cycle) in all standard frequencies and phases. It is powered by single-cylinder, air-cooled, 4-cycle gasoline engine with stellite-faced rotating exhaust valve. Further details on request.

D W Onan & Sons Inc, Minneapolis 14, Minn.

For details on these items use post cards p 169. Identify request with item number.

CHECK THESE TOO . . .

Sprayed coil dehumidifiers . . . p 174
Waste-gas heat exchanger . . . p 176
Packing for soot blowers . . . p 178
Engine-driven arc welders . . . p 180
Turbine flow meter . . . . . p 182
Chain coupling link . . . . . p 184
Tube expanding control . . . . p 186



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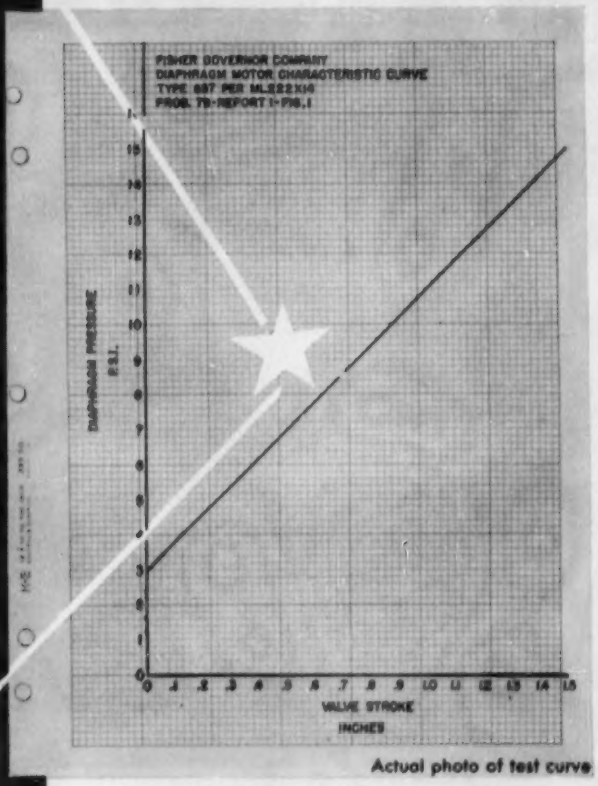
Improved Design

DIAPHRAGM MOTOR VALVES



Actual photo of test curve

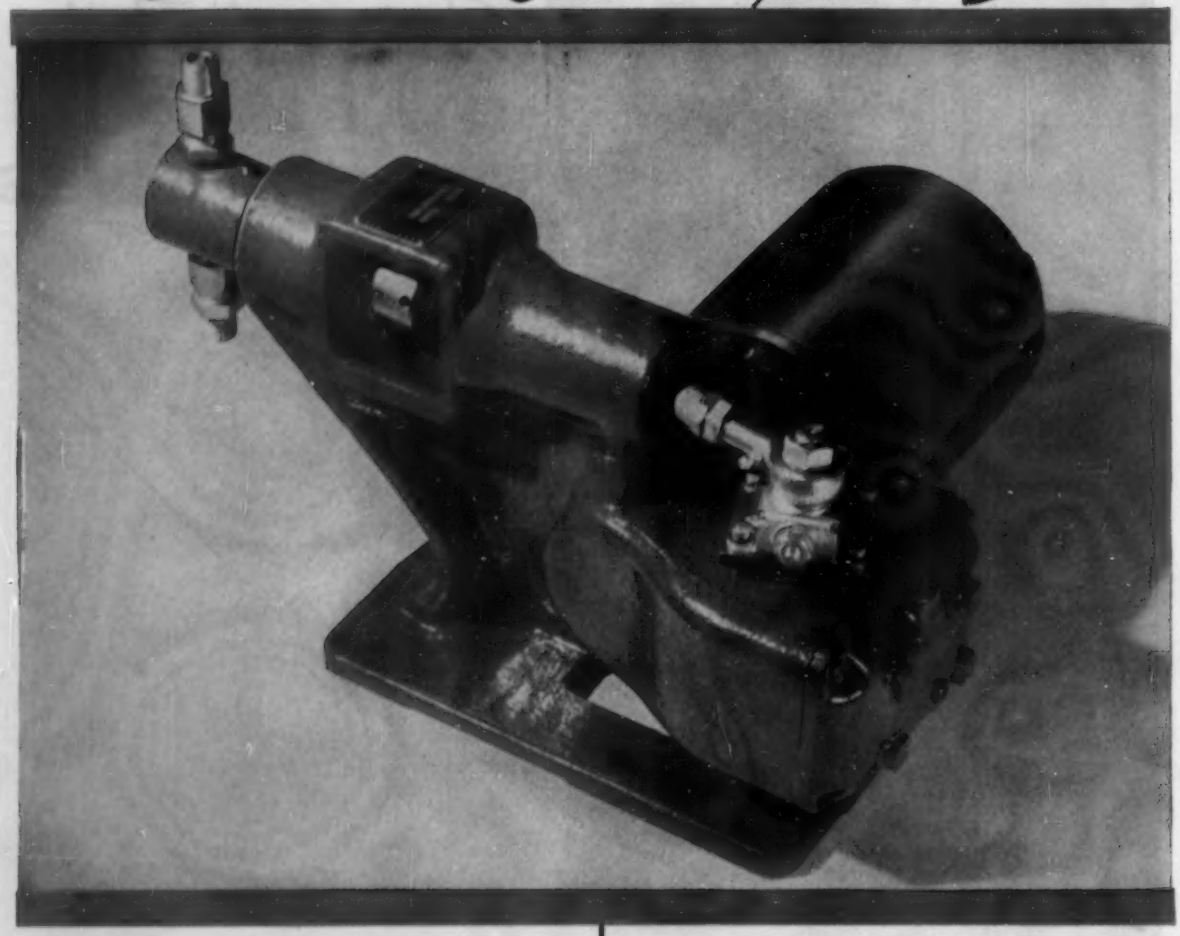
NEW SUPER STRUCTURE PROVIDES LINEARITY OF OPERATION

Special molded diaphragm, in combination with deep casing, provides constant diaphragm effective area. Resultant linear relationship between input signal and inner valve position makes *flow versus diaphragm pressure* characteristic of control valve identical to *flow versus lift* characteristic.

FISHER GOVERNOR COMPANY
MARSHALLTOWN, IOWA
Weodstock, Ontario.

FISHER
Our 75th
ANNIVERSARY

Look!



NEW CHEMICAL PROPORTIONING PUMP

More pump for less money!!! Write for prices, capacities, and specifications on the new Proportioneers Model 1105-KH. Proportioneers, Inc., 354 Harris Ave., Providence 1, Rhode Island.

PROPORTIONEERS

DIVISION OF B-I-F INDUSTRIES, INC.

BUILDERS IRON FOUNDRY • OMEGA MACHINE CO. • BUILDERS-PROVIDENCE, INC.

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New York 36, N. Y.

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330 West 42nd Street
New York 36, N. Y.

AIR CONDITIONING, VENTILATION

1 **Venting fundamentals** as applied to flammable-liquid storage and process tanks is subject of 12-p bulletin. Includes photos and diagramatic drawings. The Protectoseal Co, 1930 S Western Ave, Chicago 8, Ill.

2 **Dust-collecting equipment,** bulletin 636-3, offers engineering info on *Dustkop* control—its installation, operation and maintenance. Bulletin 622-3 offers technical data on *Mistkop* industrial vapor collectors. Specify bulletin desired. Aget Manufacturing Co, Adrian, Mich.

★ **Heavy-duty fans** designed in eight general categories for ventilating under all kinds of conditions. Available with direct or V-belt drive. ★Request bulletin AA-101 direct on company letterhead from Chicago Blower Corp, 9869 Pacific Ave, Franklin Park, Ill.

★ **Dry-type fluid coolers** for economical liquid or gas cooling are detailed in 8-p bulletin S-395. Contains photos, applications, info on construction, performance, maintenance. ★Request direct on company letterhead from The Trane Co, La Crosse, Wis.

BOILERS AND AUXILIARIES

3 **Heating boilers** for automatic firing of oil, gas or coal—or for hand-fired coal, are described in 8-p bulletin S-55. Includes cross-section installation and dimensional views with engr data for 19 standard sizes. Erie City Iron Works, Erie, Pa.

4 **Technical reprint,** "Eleven ways to avoid boiler tube corrosion," contains data resulting from an extensive study on part of company's metallurgical staff. Bulletin TR-527. Tubular Products Division, The Babcock & Wilcox Co, Beaver Falls, Pa.

5 **Boiler feed pumps,** in sizes from 1200 to 3600 psig and 300 to 3500 gpm, are described in 16-p bulletin 05B7899. Allis-Chalmers Manufacturing Co, 953 S 70th St, Milwaukee, Wis.

6 **Refractory castables.** Four-page bulletin 350 contains data on company's standard refractory line. Special section is also devoted to mixing instructions. J H France Refractories Co, Snow Shoe, Pa.

MAINTENANCE MATERIALS

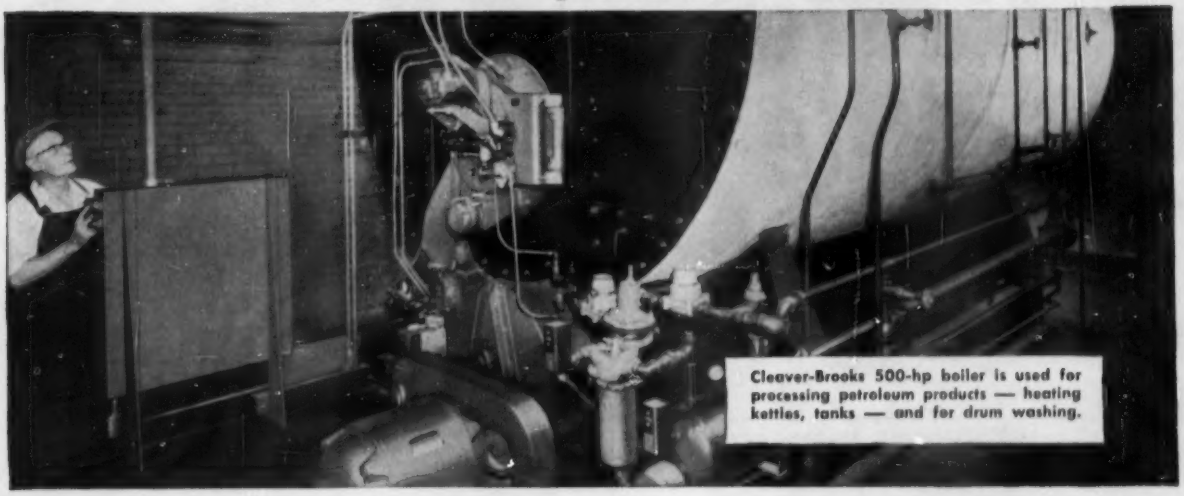
7 **Unitary mechanical seals** designed for use on process pumps are subject of 12-p bulletin AD-151. Full info, sectional drawings and diagrams. The Garlock Packing Co, Palmyra, N. Y.

8 **Vibration mountings** for medium and heavyweight machinery are described in 4-p bulletin FP-55. Includes construction details, load capacities and frequencies, typical installations. T R Finn Co, Inc, Industrial Div, 200 Central Ave, Hawthorne, N. J.

(*Continued on page* 220)

"We heard Cleaver-Brooks Boilers were OK"

. . . and what an understatement that proved to be for a Milwaukee petroleum marketer*



Cleaver-Brooks 500-hp boiler is used for processing petroleum products — heating kettles, tanks — and for drum washing.

Look at the record:

350 gallons of fuel oil saved per day!

On an annual basis — that's more than 90,000 gallons of oil saved.

Complete shutdown flexibility with the assurance of fast steaming from a cold start is the key to these remarkable savings for a petroleum processor and marketer in Milwaukee, Wisconsin. Now, a Cleaver-Brooks 500-hp boiler operates 10 hours a day, 5 days a week, where formerly two 150-hp units operated continuously 24 hours a day, 7 days a week. Fewer boiler working hours also saves up to $11,000 yearly in maintenance.

By replacing outmoded equipment, this petroleum processor also enjoys the benefits of guaranteed 80% operating efficiency, four-pass design, forced draft, 5 sq. ft. of heating surface per boiler-hp and fully-automatic firing. Cleaver-Brooks Company, Dept. P, 301 E. Keefe Ave., Milwaukee 12, Wisconsin — Cable Address: CLEBRO — Milwaukee — all codes.

*Name supplied upon request.

Look at these "before-and-after" facts

	NEW (1) 500-hp Cleaver-Brooks boiler	OLD (2) 150-hp obsolete boilers
FUEL CONSUMPTION	450 gal. per day (10-hr. day) 46 gal. per hour (operating hour)	800 gal. per day (24-hr. day) 60 gal. per hour (operating hour)
SCHEDULED STEAM SERVICE	Automatic firing from 6:30 a.m. to 4:30 p.m. Fast steaming from a cold start.	Continuous 24-hr. operation. Couldn't shut down. Wasted heat. No benefit from extra hours of operation.
OVERALL EFFICIENCY	Average 125 lb. of steam per gal. of oil.	Average 96 lb. of steam per gal. of oil.
OVERALL MAINTENANCE	Cleaned every 6 months. Single maintenance foreman.	Cleaned every 6 weeks. Required extra fireman for weekends.

Let us help you beat the penalties of boiler obsolescence — with a modern Cleaver-Brooks installation. Sizes from 15 to 600 hp, 15 to 250 psi — steam or hot water, for heating or processing. Write for catalog.

Cleaver Brooks 25th YEAR

TWENTY-FIVE YEARS OF LEADERSHIP BY THE ORIGINATORS OF THE SELF-CONTAINED BOILER

George Edwards' Scrapbook

These 1890 *Power* ads help us look into the future

► When Editor Lou Rowley showed me a stack of monthly survey cards from readers on my last trip to New York, I noticed many of them commented, "I find the ads in Power very interesting and helpful in my work." That's why I looked up an 1890 bound volume to compare ads.

Now, Power ads are an education to me. They keep me abreast of new equipment and some of them give valuable engineering data. Fact is, I always feel cheated when I pick up an engineering magazine and find it short on ads. I guess that's why the supermarkets and department stores have become so popular. You find in one space almost everything that we used to buy from a number of stores. But best of all, every popular brand name of any one product, like coffee for example, is there—take your pick. And if your favorite brand isn't in the lineup—quite often you buy another brand.

I notice that back in 1890 many power-equipment makers knew what the supermarkets know today. Most of the successful steam-engine manufacturers of that day ran ads in Power. There are pages of them. And, of course, The Corliss Steam Engine Co at the top of this page headed the list. The Corliss engine was the glamour girl of engines then, and that successful firm also found it profitable to keep its name in this young, lusty, dynamic magazine.

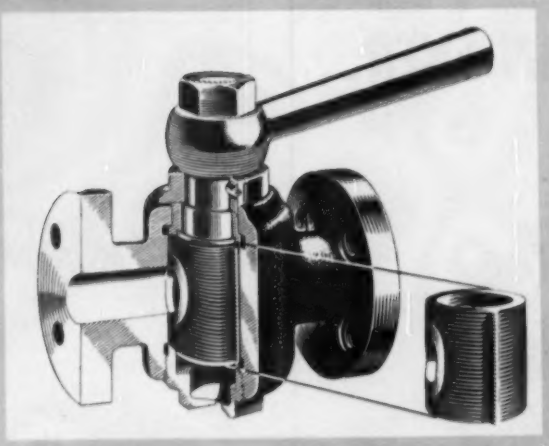
Allis-Chalmers Co, Babcock & Wilcox Co, Combustion Engineering Co, Jenkins Bros, Link-Belt Co, Mason Neilan Regulator Co, Wm Powell Co, Westinghouse Electric Corp and Worthington Corp are among the companies that have been advertising in Power since 1884. Some of these firms were one-horse outfits then. But look how keeping their names before us engineers has helped them.

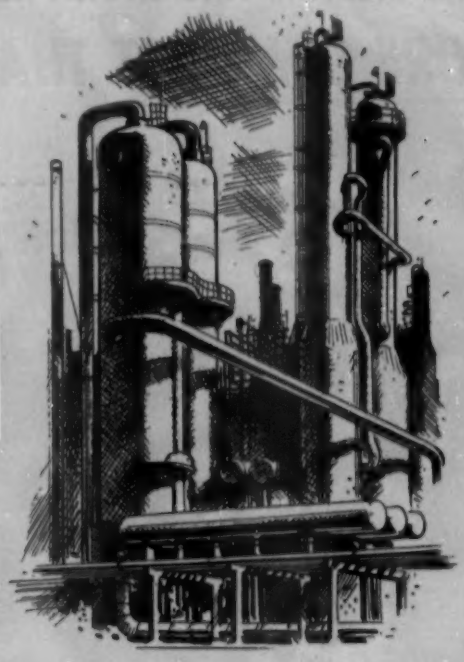
Power was a weekly then. Most of the ads were about steam engines. Next came boilers, then mechanical packing, heat exchangers and boiler-water treatment chemicals. A few electric motors and generators, eight times as heavy per horsepower as today, appeared here and there. The age of electricity was just around the corner. It was slightly ahead of where atomic power is now.

But one thing that interests me is that, by looking at nothing but ads in those old copies, you know just about what the power picture looked like then, what kind of plants we had and what kind of machinery was in those plants.

Wouldn't it be something if we could look into the future and see Power ads 70 years hence—say, in 2025? Wonder how many firms well-known today will be around then?

George Edwards
Engineer





Tightness tells with the Klinger sleeve-packed cock!

In the last quarter of a century Klinger Sleeve-Packed Cocks have steadily replaced the old-fashioned asbestos-packed cocks with their limitations of working pressure, difficulty of repacking, and tendency to jam. They are available in a wide range of designs and sizes for all purposes and pressures and with the following outstanding advantages:—

Renewable "Klingerit" Packing Sleeves. Parallel-ground and non-jamming plug. Can be re-tightened during operation. Unobstructed straight-thru full bore.

Write for the Klinger Master Catalog, which describes the complete range of Klinger products, compressed asbestos sheet jointings and packings for every purpose, seatless piston valves, sleeve-packed cocks, reflex and thru-vision level indicators and rings and seals in natural, synthetic and silicone rubbers and other synthetic materials.

Klinger

RICHARD KLINGER LIMITED, KLINGERIT WORKS, SIDCUP, KENT, ENGLAND

Agents throughout the World

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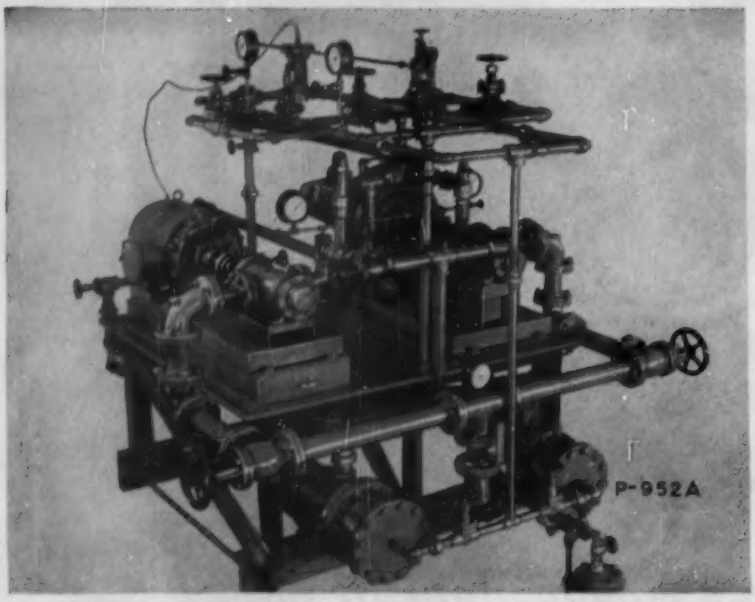
COMPLETE RANGE OF SIZES AND MODELS IN BOTH MEDIUM AND HIGH PRESSURE TYPES

MORE COMPACT THAN EVER..



P-952A—Steam Turbine and Electric Motor drive gives flexibility in this compact Model P-852H size No. 25 unit.

NATIONAL AIROIL

FUEL OIL PUMPING AND HEATING UNITS

NATIONAL AIROIL Fuel Oil Pumping and Heating Units are specially designed to prepare, for combustion, all grades of fuel oil including No. 6 or Bunker "C" Oil and residuums. They will draw fuel oil from above ground or underground tanks, preheat it to proper constant temperature and deliver it to Oil Burners at an even pressure, best suited for the burners. Our Fuel Oil Pumping and Heating Units are the result of years of experience. They come completely equipped ready for steam, exhaust, condensate, oil suction, oil return, and electrical connections. All valves, regulators, etc., are readily accessible. The piping arrangement is easily understood. These compact, space-saving units are available in a range of sizes and models in both Medium and High Pressure types. For complete details, write for our Bulletin 40 — very interesting and informative.

OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes
STEAM ATOMIZING OIL BURNERS
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MOTOR-DRIVEN ROTARY OIL BURNERS
MECHANICAL PRESSURE ATOMIZING OIL BURNERS
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LOW AIR PRESSURE OIL BURNERS
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GAS BURNERS
COMBINATION GAS & OIL BURNERS
FUEL OIL PUMPING and HEATING UNITS
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AIR INTAKE DOORS
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SPECIAL REFRACTORY SHAPES

NATIONAL AIROIL BURNER CO., INC.

1250 EAST SEDGLEY AVE., PHILADELPHIA 34, PA.
Southwestern Division: 2512 South Boulevard, Houston 6, Texas

More EQUIPMENT NEWS

Begins on page 160

Sprayed coil dehumidifiers

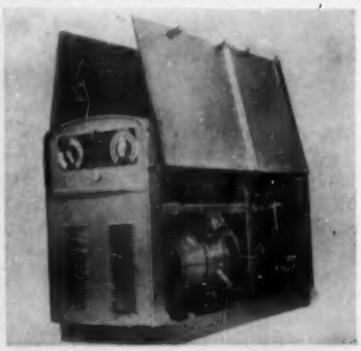
1220 • Central-station-type sprayed coil dehumidifiers are available in standard arrangements having 1, 2 or 3 coils high and from 4 to 8 coil rows deep. Finned tube length can vary from 2 to 10 ft; coil face area from 4 to 83 sq ft; capacity from 2300 to 45,900 cfm. Recirculation spray-water requirements range from 5 gpm for the smallest unit in the line to 84 gpm for the largest.

An access door on air-output end of unit provides quick access to coils, drain trough and tank in that area. Coils themselves are removable from either connection box side or from air-intake or air-output end of unit. Eliminators are also removable. Spray nozzles, float valve, strainer, coil face, drain troughs and tank are accessible through air-inlet end of the dehumidifier.

Face and by-pass dampers are available as an optional accessory.

American Blower Corporation, Detroit 32, Mich.

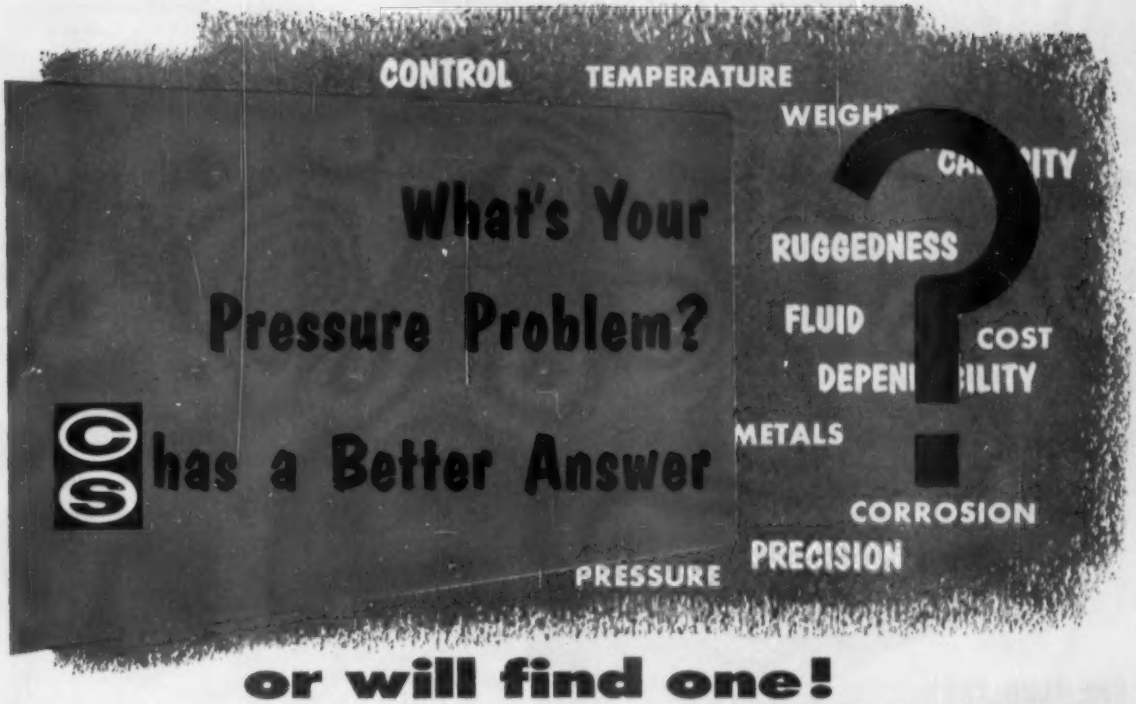
For more data on these items, use post cards p 169. Identify your request with item number.



Diesel-driven welder

1221 • Designed for construction, pipeline and structural welding, unit is rated 250 amps at 40 volts, 60% continuous duty cycle. Arc can be controlled as to type and intensity. Unit has range of 50 to 250 amps, handling electrodes from 1/16 to ¼-in. diameter. Improved fuel system of engine maintains accurate current output both in arc striking and throughout range of welder, according to manufacturer.

Unit is powered by a 4-cylinder, 4-cycle diesel engine with 166 cu in. displacement, rated at 39 hp at 1700 rpm. It is equipped

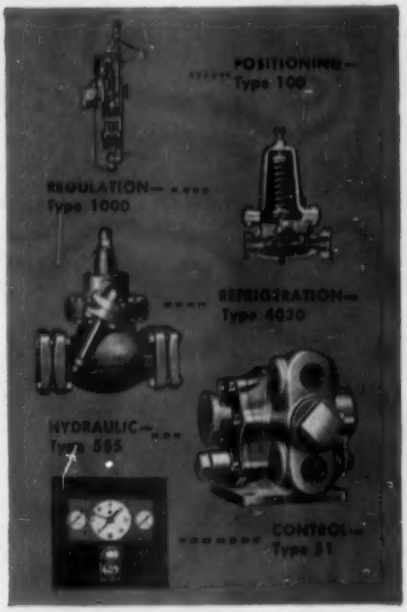


or will find one!

Finding or developing answers that *best suit* individual pressure problems has been Cash Standard's specialty for over a quarter of a century. The solution to *your* problem can be found either in the established Cash Standard line of pressure regulators, instruments and automatic controls, or in Cash Standard's willingness to tackle problems—to modify existing products or design new products to conform precisely to your needs.

For an individual solution to *your* pressure problem, contact the Cash Standard pressure specialist in your area, or write for pressure problem analysis.

Some Applications Served by Cash Standard Pressure Products



Write Dept E

CASH STANDARD

A. W. CASH COMPANY, P. O. Box 551, Decatur, Illinois

Pressure, Hydraulic, Temperature, Process and Combustion Controls

Here's How to Handle Corrosives at High Peripheral Speeds

CHEMLON YARN PACKING STYLE C-30 Made of TEFLON* FIBER BY "JOHN CRANE"

Chemlon Yarn Style C-30 extra tough packing gives you two important advantages not provided by other types of braided or molded Teflon packing: 1) positive sealing efficiency at high peripheral speeds; 2) cooler running stuffing box under severe service conditions.

Style C-30 can be used to handle the most destructive acids, alkalis or solvents. The excellent thermal properties of Teflon, combined with the softness, resiliency and fluid retentive properties of fine fiber construction, adapt it to high temperature conditions to +300°F. The packing is made firm and dense by means of a special process which eliminates *large* voids.

HERE'S PERFORMANCE PROOF:—Fluid handled: 45% H_2SO_4 (impure) at 170°F.—Operating conditions: 1¼" pump shaft at 1700 rpm. or 555 fpm. peripheral speed. Results: 46 days good service. Previous best service record 7 to 10 days.

Chemlon Yarn Packing Style C-30 is available in spool or coil form, in a wide range of sizes from ⅛" up. *Can be lubricated with Teflon suspensoid or various types of lubricants.*

Send for Bulletin No. P-321. Crane Packing Co., 1830 Cuyler Avenue, Chicago 13, Illinois. In Canada: Crane Packing Co., Ltd., 617 Parkdale Ave., N., Hamilton, Ont.

*DuPont Trademark

JOHN CRANE CRANE PACKING COMPANY 38 YEARS INDUSTRIAL PROGRESS

OFFICES IN ALL PRINCIPAL CITIES

More EQUIPMENT NEWS

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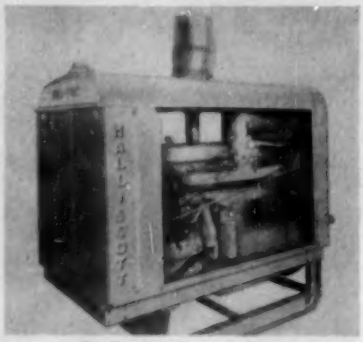
with a 12-volt starting motor and an ether injection system for cold weather starting.

The Lincoln Electric Company, Cleveland 17, Ohio



Industrial engines

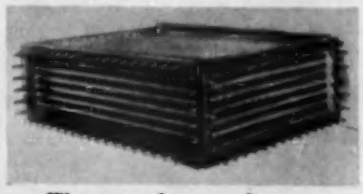
1222 • *Model 590-0* industrial engine develops more than 200 hp—weighs less than 1300 lb. It is suitable for replacement as well as original equipment installations in water wells, oil fields, light plants and other services.

Available for gasoline, liquid petroleum gas or natural fuels, it has a 5-in. bore and stroke. Unique head design with overhead camshaft and rockerarms actuating overhead valves permits placing valves on both sides of center line of head so that larger valves with ample water jacketing can be used.

Block and pistons can be replaced without removing the crankcase from the engine. Long studs in crankcase pass completely through cylinder block and head, holding engine rigid but permitting rapid disassembly and replacement of single units. Further data on request.

Hall-Scott Motors Company, 2850 7th St, Berkeley, Calif.

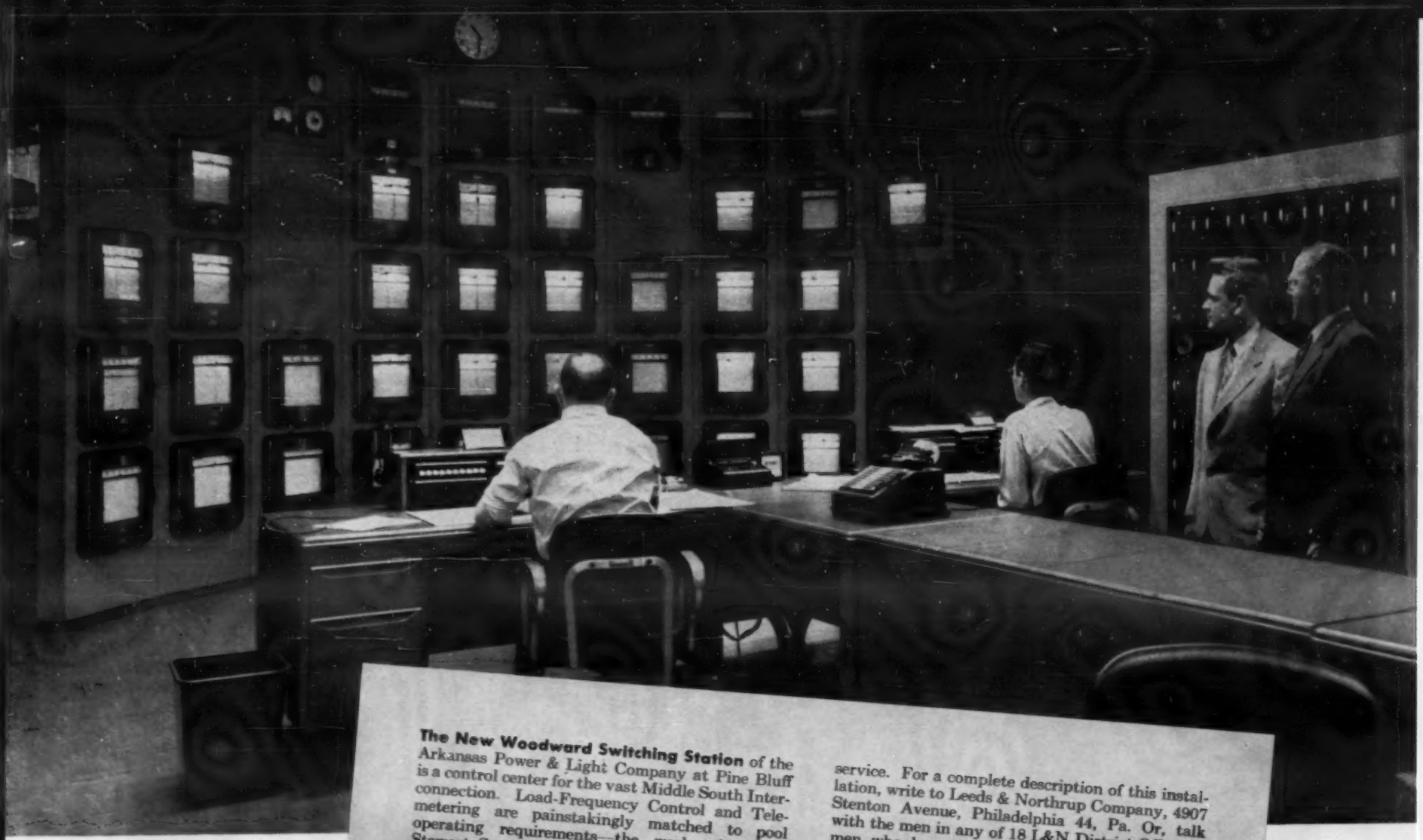
For more data on these items, use post cards p 169. Identify your request with item number.



Waste-gas heat exchanger

1219 • New heat exchanger with finned-plate design has been developed for recovery of heat from high-temperature waste gases. It is designed to withstand gases at pressures to 100 psi and temperatures to 1100 F. Among applications are: as a gas turbine regenerator, recovery of stack gas heat for preheating furnace or kiln air, heating or cooling process gas or plant air, other gas-to-gas services such as vapor-to-vapor exchangers in petroleum processes.

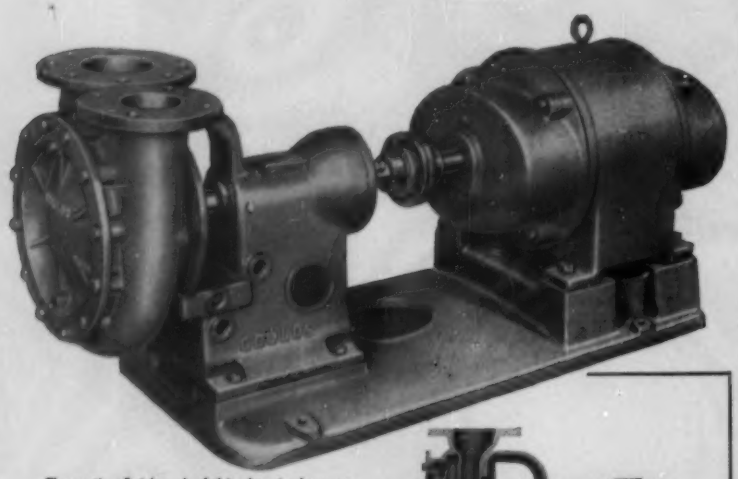
Individual cell of the exchanger, photo, consists essentially of three parts: (1) corrugated sheets (2) formed and butt-welded flat tubes (3) blanked and extruded sheet metal tube sheets. All sealing



The New Woodward Switching Station of the Arkansas Power & Light Company at Pine Bluff is a control center for the vast Middle South Interconnection. Load-Frequency Control and Telemetering are painstakingly matched to pool operating requirements—the work of E. C. Stewart, Systems Operator, in concert with a team of Leeds & Northrup Design and Application Engineers, two of whom are shown (standing) here. End result of their combined efforts: lowest operating cost consistent with reliable customer service. For a complete description of this installation, write to Leeds & Northrup Company, 4907 Stenton Avenue, Philadelphia 44, Pa. Or, talk with the men in any of 18 L&N District Offices—men who have made more than 300 matched-control installations.

LEEDS LN **NORTHRUP**

300 Load-Frequency Control Installations 1927-55



The entire fluid end of this chemical pump is available in any of the following metals: 316, Gould-A-Loy 20, 304, all iron, all bronze or bronze fitted, all iron with stainless trim. Nine sizes ranging from ¾" to 3"; capacities up to 720 GPM; heads to 200 ft.

You get a lot for your money

in this new chemical pump

New design features of the Goulds Fig. 3715 centrifugal pump offer you special operating and maintenance advantages in handling acids, alkaline liquors, and slurries.

The liquid end of the Fig. 3715 is the same as in its immediate ancestor, the Fig. 3705. Thousands of severe-service applications have shown us no way to improve it. But the support head is completely new. It's a sturdy, box-type design with water cooling which raises the maximum liquid temperature limitation to 350° F. It has grease-lubricated standard bearings with grease relief that helps prevent over-lubrication . . . and a simple, positive external arrangement for adjusting impeller clearance without any dismantling.

With the stuffing box under suction pressure only, you will have infrequent need for re-packing and a new freedom from excessive leakage. You can inspect and clean the interior, and you can remove or replace the impeller, without disturbing suction and discharge connections.

Bulletin 725.4 describes *all* the operating and maintenance advantages of the Goulds Fig. 3715 chemical pump. It defines the extensive standardization this design accomplishes for simplifying your parts inventory. It gives you detailed performance curves. We will be glad to send you a copy. Just write for Bulletin 725.4.

MEMBER

Goulds PUMPS INC.
Seneca Falls
New York

ATLANTA • BOSTON • CHICAGO • HOUSTON • NEW YORK • PHILADELPHIA
PITTSBURGH • TULSA

More EQUIPMENT NEWS

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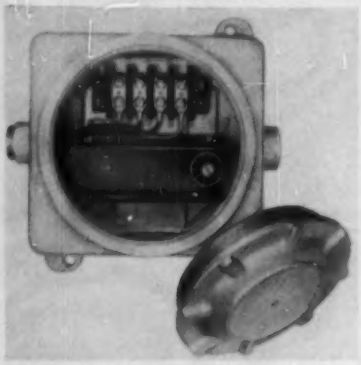
surfaces are heliarc welded to insure tightness. Surfaces are covered with a protective nickel-base brazing alloy that also joins the corrugated sheets to the tubes. This alloy and its application technique is claimed by the manufacturer to resist high-temperature oxidation and corrosion from hot combustion products, sea water, many acids and other chemicals.

The Griscom-Russell Company, Massillon, Ohio

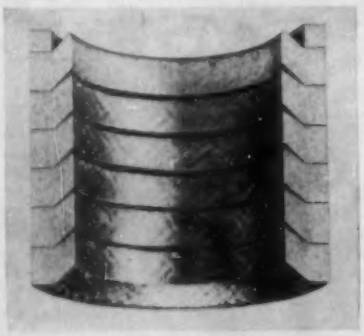


Vibration monitor

1228 • Explosion-proof vibration monitor detects mechanical malfunctions such as failing bearings or unbalance. Applications include gas engines, pump motors, large fans and blowers, etc. Unit offers supervisory protection for infrequently attended equipment by actuating a warning or causing a shutdown the instant a malfunction develops. Electrical rating is 5 amps at 115 or 230 volts ac, resistive or inductive. Aluminum housing is designed for Class I, Group D, Class II, Groups E, F and G and Class III locations.

The Beta Corp, Forest Ave at Ridge Rd, Richmond 26, Va.

For more data on these items, use post cards p 169. Identify your request with item number.



Packing for soot blowers

1224 • Special packing for soot blowers is made of high-grade asbestos yarn braided over a plastic core of heat resistant composition, then lubricated with mica. It may also be graphite-lubricated. Design is a combination of lip-type and solid packing arranged so solid part takes the gland pressure. This leaves the lips free to act upon the pipe or tube. Actuated by fluid

why soot is no problem... with the Ljungstrom® Air Preheater

Soot is no problem with the Ljungstrom. Clinging soot or slag is loosened by normal expansion and contraction of the preheater . . . and most of it is blown away by the high-velocity gas streams. What remains is removed by superheated steam or compressed air, fired from oscillating soot blowers, while the Ljungstroms are in operation.

What's more, moderate deposits on the Ljungstrom heating surface have no effect on preheating. For, with the Ljungstrom, heat need not pass through a film-coated wall — but is simply absorbed by a heating surface and *released from the same surface.*

Get all the details on why the Ljungstrom is easier to clean and maintain . . . maintains higher boiler efficiencies. They're in the new, 38-page reference manual, "Ljungstrom Air Preheaters." Write for your free copy, today!

Advantages of the Ljungstrom Air Preheater

- Size for size, recovers more heat than any other type.
- Reduces fuel consumption. Permits use of lower-grade fuels. Increases boiler output and reliability.
- Eliminates cold spots . . . keeps corrosion to a minimum.
- Easier, faster to clean and maintain.
- Requires far less supporting steel and is quickly erected.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

ROTOJET®
Tube Cleaners

Clean tubes and pipes from ½" to 12" I.D. THOROUGHLY QUICKLY

ROTOJET Model 512 Air-driven Motor, universal joint, swing-frame head, and solid brush.

ROTOJET Junior Model 532 Air-driven Motor, universal joint, cone cutter.

ROTOJET Junior Model C434 Air-driven Motor flexible coupling, expanding brush.

ROTOJET Model C-525 Air-driven Motor with swing-frame head and universal joint.

ROTOJET Model C-526 Air-driven Motor with pivot head and universal joint.

Our large stock of Rotojet air-driven and water-driven tube cleaners, accessories, and repair parts for straight and curved tubes, pipes, and transfer lines is available to meet most requirements without delay. Tube cleaner specialization for 43 years assures satisfactory results from any Rotojet equipment we recommend. Send for Bulletins J-410 and R-105. For quick action wire or phone, HUmboldt 3-0570.

ELLIOTT COMPANY-ROTO DIVISION

153 SUSSEX AVE. • NEWARK 1, N. J.

More EQUIPMENT NEWS

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pressure, lips provide a tight seal with minimum friction. Manufacturer reports that this packing withstands high-pressure superheated steam without hardening, drying out or vulcanizing during exposure to heat. Sturdy construction permits it to act as a bearing when needed.

Johns-Manville, 22 E 40th St, New York 16, N. Y.

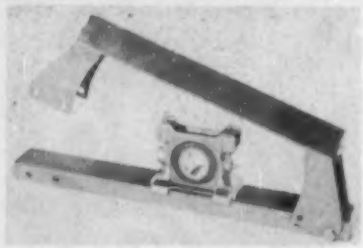
Engine-driven arc welders

1234 • Two ac arc welders, *models GEA200 and GEA200L,* are designed for field production and maintenance welding applications where ac or ac-dc electrodes of 1/16 to 3/16 in. diameter are required. Rated welding current is 200 amps, 100 cycle, single phase with a 100% duty cycle. Welding current range is 15 to 200 amps. Open circuit voltage is 85 v.

In addition to welding power both models provide 1-kw, 110-v dc auxiliary power. *Model GEA200L* also can be used to supply 4.5 kw, 110 to 220 v, 60 cycle, single-phase ac power, identical to that supplied by normal power service lines.

Air Reduction Sales Co, div of Air Reduction Co, Inc, 60 E 42nd St, New York 17, N. Y.

For more data on these items, use post cards p 169. Identify your request with item number.



Improved conveyor takeup

1235 • Improved *DS* takeup has a one-piece hinged-top frame that permits easy access to bearing block and adjusting screw. The top swings upward after three bolts are removed from the base.

New arch-frame design adds strength to end brackets. Unit is interchangeable with previous designs for use on a variety of materials-handling equipment such as apron, belt, chain, drag, flight and slat conveyors—providing a positive means of adjustment.

Units are available with babbitted, ball or roller bearings. Heavy bearing blocks have a longer base and are interchangeable with previous designs. Babbitted blocks

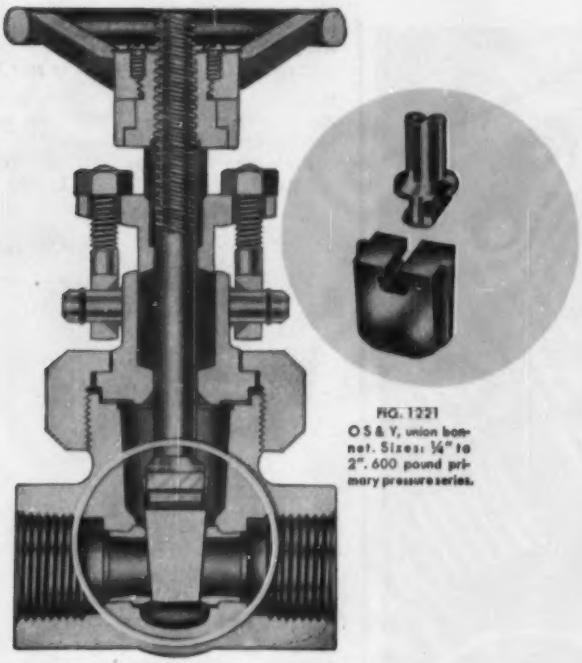


FIG. 1221
O S & Y, union bonnet. Sizes: ¼" to 2". 600 pound primary pressure series.

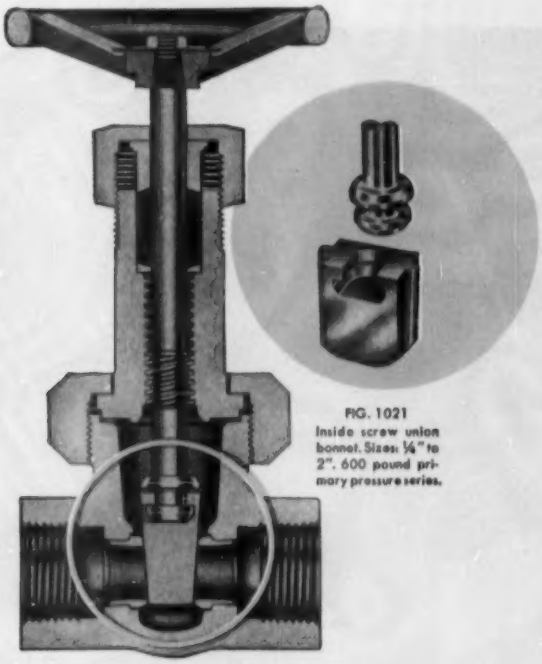


FIG. 1021
Inside screw union bonnet. Sizes: ¼" to 2". 600 pound primary pressure series.

New design makes OIC forged steel gate valves the most modern line . . .

NEW: stronger stem-to-wedge connection. Improved, modern design increases pull-out strength to many times the theoretical requirement. This design distributes the pull-out load more efficiently throughout the wedge structure to meet the most stringent specifications of valve buyers in all fields.

NEW: wedges wear longer. Wedges are made of 13% chrome stainless steel for corrosion resistance. They are duracased to at least 1000 Brinell Hardness to prevent galling and excessive wear caused by frequent closures upon foreign particles in the flow.

NEW: union bonnet design is more efficient. Body-to-bonnet joint of the male-female type provides a recess for the gasket. It is contained more securely, reducing the possibility of leakage or a blown gasket.

OTHER OUTSTANDING FEATURES

Stem threads of all OIC inside screw, forged steel valves are always contained inside the bonnet. They can't possibly load up with corrosive matter which might be in the flow. This keeps the threads clean and free running, and contributes to longer stem wear.

Modern OIC Seal-Ever packing is a special composition which eliminates electrolytic action between the stem and the packing. This prevents stem corrosion in the packing area and helps maintain a leakproof seal.

Back-seating feature provides means of repacking valves while in service.

OS & Y valve gland "I" bolts are retained on trunnions by modern, more efficient, stainless steel snap rings.

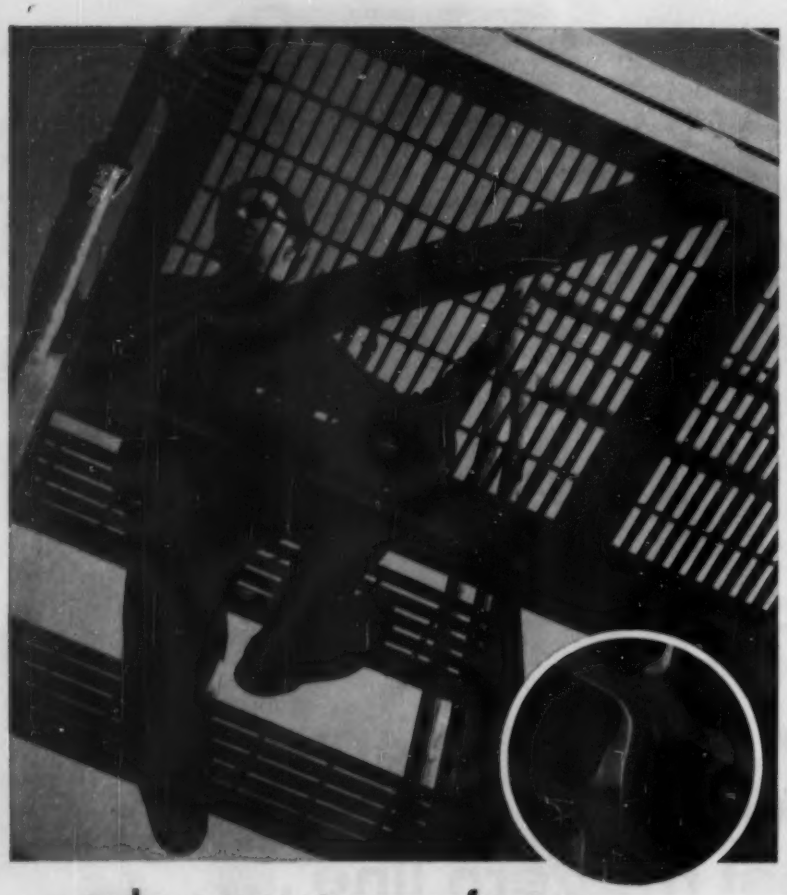
Shoulder-type seat rings are expanded into the body under heavy pressure. They are accurately machined to mate tightly with the wedge for a positive seal.

Order modern OIC Forged Steel Valves from your nearby OIC Distributor. Write and request Folder No. 195.

OIC Forged Steel Valves are also available in globes, angles and checks in a variety of trims for any service.

THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO

OIC VALVES | **FORGED & CAST STEEL, LUBRICATED PLUG, BRONZE & IRON**



... make every step a safe step

BLAW-KNOX ELECTROFORGED®
STEEL GRATING and STAIR TREADS

Outdoors or indoors, throughout your plant, you can provide safe walking conditions on catwalks, stair treads, walkways, platforms and floors. For Blaw-Knox Electroforged Steel Grating brings you these exclusive features:

1. rigid one-piece construction—easy to install
2. non-slip twisted crossbar—for safe footing
3. three types of bearing bars
   - square bars—for smoothest walking surface
   - knurled bars (Furro-Grip)—for extra safety plus relatively smooth walking surface
   - serrated bars—for maximum safety under extremely hazardous skid conditions
4. no sharp corners to clog—self-cleaning
5. all surfaces accessible—easy to paint
6. maximum open area—for light and ventilation

Write for your copy of new Bulletin No. 2486
—or send dimensional sketch for quotation.

BLAW-KNOX

BLAW-KNOX COMPANY
BLAW-KNOX EQUIPMENT DIVISION
Pittsburgh 38, Pennsylvania

GRATING APPLICATIONS: floors • platforms • walkways • catwalks • stair treads • fan guards • shelving • and many other uses, both outdoors and indoors, for versatile steel grating

More EQUIPMENT NEWS

Begins on page 160

have pipe top for grease cup or fitting. Ball or roller bearing blocks come with hydraulic-type fittings.

Link-Belt Co, Dept PR, 307 N Michigan Ave, Chicago 1, Ill.

Quick-opening valve

1227 • Steel, quick-opening valve is designed for service at 600 psi at 800 F and 1200 psi at 100 F. They are recommended for use on steam, hot water, air, gases, etc. Design and construction features assure fast, positive openings and closures at pressures to 1200 WOG, according to manufacturer. Details on request.

The Klinger Corp of America, 95 River St, Hoboken, N. J.

For more data on these items, use post cards p 169. Identify your request with item number.

Turbine flow meter

1225 • Instrument gives precise flow rate measurement (± ½ of 1% of rate) up to 100,000 lb per hr at specific gravity 1.0, according to manufacturer. Range is 20:1. Accuracy is not affected by piping configuration. Maximum pressure drop is 7 psi.

Meter consists of a fluid-driven rotor mounted in a short housing installed in the pipeline. Rotor turns at a speed directly proportional to fluid velocity. Rotor blades are of a magnetic material, and as each blade passes a pickup coil containing a magnet, it induces an electrical pulse. Number of pulses produced is directly proportional to speed of blade rotation and number of blades.

Pulse frequency of output may be fed into a converter where it is converted to a dc voltage linearly proportional to input. An indicating potentiometer translates voltage level to true rate indication.

Specific gravity corrections are fed man-

6 ADVANTAGES OF A. P. GREEN PLASTIC AND CASTABLE REFRACTORIES IN WATERTUBE BOILERS

MONOLITHIC CONSTRUCTION

A monolithic refractory lining, properly installed, gives better combustion efficiency and longer, more trouble-free service than any other type lining.

ANCHORED FURNACE LININGS

A. P. Green "floating" anchors hold the refractory lining securely against the casing and permit free expansion and contraction movement.

AIR-COOLED—SECTIONALLY SUPPORTED WALLS

A. P. Green offers a simple design for air-cooled walls—no special tile are required. Provision for recovery of preheated air can be made. Alloy supporting plates are available for use in extremely high walls, over stoker arches, and burner openings, permitting replacement of any section without disturbing the adjacent areas.

LESS HEAT LOSS THROUGH WALLS

The low thermal conductivity of A. P. Green plastic and refractory castables means less heat loss through the walls, greater efficiency, and more protection for the outer casing of the boiler.

LOWER INSTALLATION COSTS

Special shapes are eliminated. Expensive, time-consuming brick cutting is not necessary. With proper supervision, the installation can be done by average labor.

EXPERIENCED DISTRIBUTORS—QUALITY WORKMANSHIP

An authorized A. P. Green distributor, trained in refractory problems, is close to your job to give you the kind of quality workmanship your refractory job demands. He is backed by the engineering staff of the A. P. Green Fire Brick Company.

A. P. Green REFRACTORY PRODUCTS

A. P. GREEN FIRE BRICK COMPANY
Mexico, Missouri, U. S. A.
PLANTS: Mexico, Mo. • Woodbridge, N. J. • Sulphur Springs, Texas
In Canada: A. P. GREEN FIRE BRICK COMPANY, LTD.
Toronto 15, Ontario

Distributors in the Principal Cities of the World

Send for this free booklet

PLEASE SEND ME A COPY OF YOUR BOOKLET ENTITLED
"A. P. Green Refractory Linings for Watertube Boilers."

NAME_____

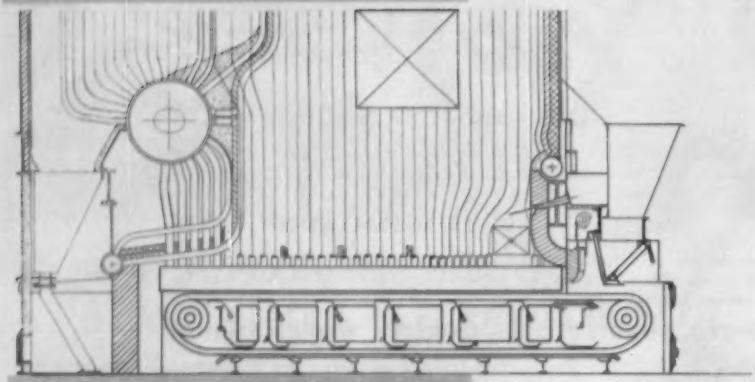
COMPANY NAME_____

ADDRESS_____

CITY_____ STATE_____

A. P. GREEN FIRE BRICK CO., MEXICO, MISSOURI, U. S. A.

No Special Stoker Protection Needed When Burning Gas Over Laclede Chain Grate Stokers



Laclede Chain Grate Stoker users switch over from coal to gas by simply turning on the gas and turning off the stoker. The ash bed left from coal firing provides ample stoker protection.

Switch-over from gas to coal is accomplished with equal ease.

WRITE FOR INFORMATION ABOUT USERS FOLLOWING THIS PRACTICE.

CONTACT YOUR CONSULTING ENGINEER OR A LACLEDE STOKER REPRESENTATIVE NOW.

Chicago, Ill.	228 N. LaSalle St. (1)	FRanklin 2-0022
Cincinnati, Ohio	2007 Madison Rd. (8)	EAst 1-7200
Cleveland, Ohio	8905 Lake Ave. (2)	ATlantic 1-5600
Columbus, Ohio	74 East Gay St. (15)	MAin 0422
Des Moines, Iowa	520 S.W. Fifth St. (9)	Phone 3-3121
Indianapolis, Ind.	4061 Central Ave. (5)	HUmbolt 8406
Kansas City, Mo.	4706 Holly St. (2)	WEstport 7091
Knoxville, Tenn.	601 South Central (2)	Phone 3-8629
Milwaukee, Wis.	233 N. 76th St. (13)	BLuemound 8-6190
Nashville, Tenn.	490 Craighead St. (5)	Phone 97-3504
Omaha, Neb.	20th and Izzard St. (2)	HArney 9775

FOUNDED IN 1904

LACLEDE
STOKER COMPANY
4440 HUNT AVE. • ST. LOUIS 10, MO.

More EQUIPMENT NEWS

Begins on page 160

ually into the potentiometer so that indicated flow rate is in mass flow units, such as lb per hr.

Fisher & Porter Company, Hatboro 35, Pa.

Variable-speed pulley

1232 • New ¼-hp unit is designed for limited space applications. It can be mounted with the belt take-off close to the motor and/or reversed, in which case the take-off is in an overhung position away from the motor.

The pulley delivers speed ratios to 2:1. An A section belt is used. Maximum bore is ⅝ in. with keyway.

Lovejoy Flexible Coupling Co, 4870 W Lake St, Chicago, Ill.

For more data on these items, use post cards p 169. Identify your request with item number.

Chain coupling link

1233 • New coupling link enables alloy chain users to make up their own sling and special assemblies. It consists of a pair of body halves, tubular stud and hardened alloy-steel pin. It can be assembled in seconds and is securely locked by the steel pin which bites into steel stud. No peening or welding is required and the link can be disassembled and reused.

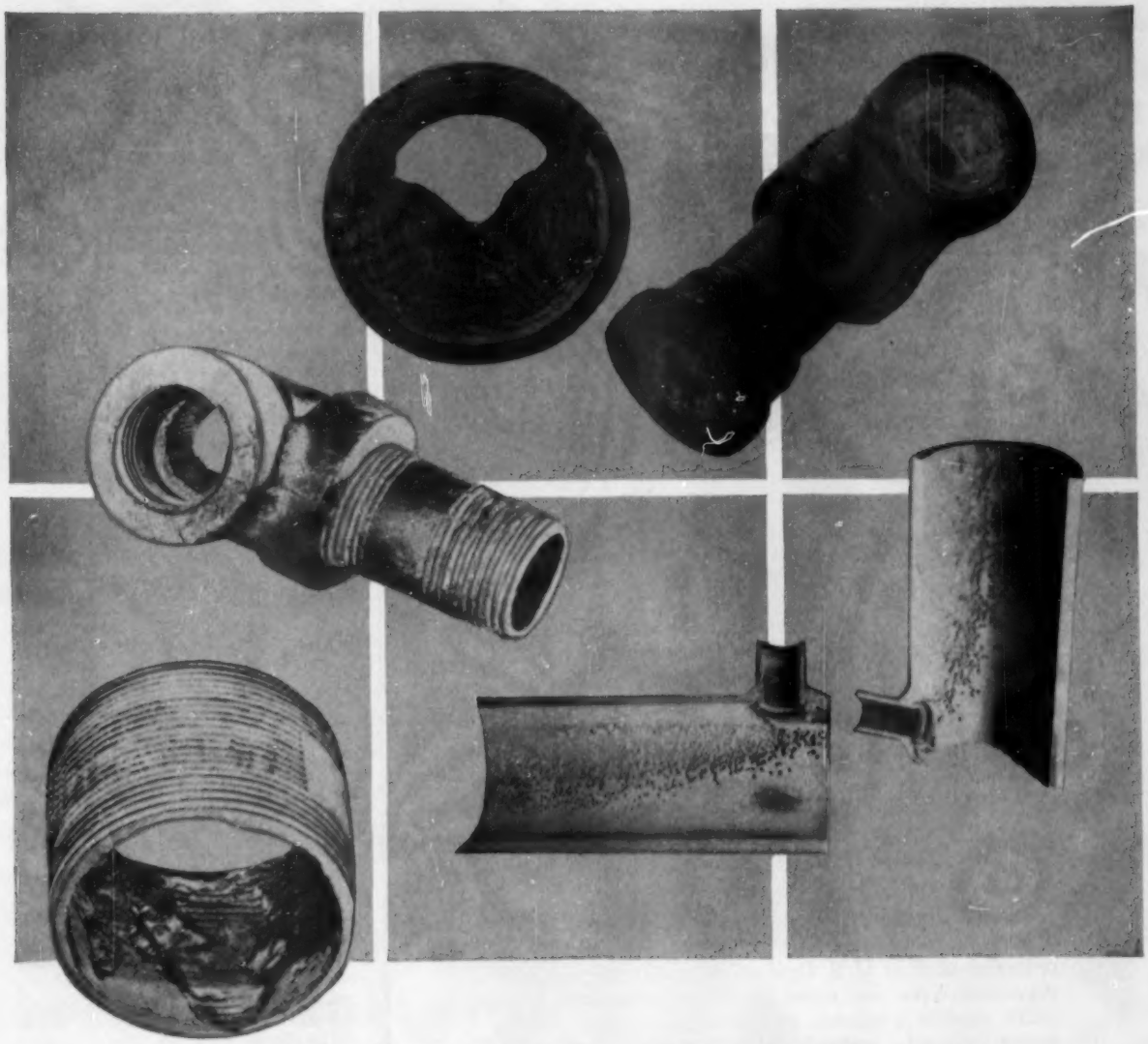
Forged from alloy steel and heat treated, the links can be used in joining attachments such as hooks and large links to body chain. Descriptive bulletin on request.

Columbus McKinnon Chain Corp, Tonawanda, New York

Warning safety device

1226 • Devised for the oil refining and chemical processing industries, this unit gives a warning indication on a pressure gage that hydrogen blisters are corroding walls of metal tanks in which chemical reaction is in process under pressure.

The device is made of seamless carbon steel tubing. One end is closed and ma-



WHAT'S YOUR TROUBLE?

Each of these destroyed parts had to be taken out of service because of incomplete or inadequate water treatment. Replacement meant loss of steam production . . . new equipment expense . . . added labor-repair costs.

DEARBORN COMPLETE WATER TREATMENT SERVICE eliminates this by providing trouble-free water—a vital necessity to every user of industrial steam. Dearborn's many years of leadership in the field of water treatment will help keep your power plant operating economically.

CALL ON YOUR DEARBORN SALES ENGINEER for (1) analysis of raw water (2) recommendation of test procedures (3) proper treatment (4) a manually or automatically controlled feeding system.

Dearborn®

combatting corrosion wherever it occurs

Dearborn Chemical Company
Merchandise Mart Plaza, Dept. Dept. PO
Chicago 54, Ill.

Please send me
- ☐ Internal Treatment Bulletin 5000
- ☐ Filmeen Bulletin 5013-A
- ☐ Dearborn "659" Bulletin 5008
- ☐ Have a Dearborn Sales Engineer call.

Name.....

Company.....

Position.....

Address.....

City.....*Zone*.....*State*.....

two famous names join forces . . .

U S G

BELMONT

for greater service to Industry

• The consolidation of product lines and sales service facilities of the United States Gasket Company and The Belmont Packing & Rubber Company creates a new major source for all your gasket, packing and allied product requirements—*plus* the most complete line of TEFLON and KEL-F stock offered to Industry, today.

It brings together the specialized engineering and manufacturing experience, and enlarged, modern production facilities of these two companies to better serve your standard and special needs.

It brings together the nationwide Industrial Distributor organizations of both companies—backed by an enlarged staff of U. S. Gasket-Belmont Packing field representatives—to make these combined lines even more readily available and profitably employed in every industrial community.

UNITED STATES GASKET COMPANY, Camden 1, N. J.

THE BELMONT PACKING & RUBBER COMPANY, Phila. 37, Pa.

U.S. GASKET—BELMONT PACKING PRODUCTS INCLUDE:

PACKINGS: MOLDED RINGS—Teflon, Asbestos Cloth, Duck. SPIRAL OR COIL PACKING—Braided and Twisted Asbestos, Braided Teflon, Extruded Teflon, Asbestos Fabric, Duck and Rubber, Flax and Jute, Metallic and Semi-Metallic. PLASTIC PACKING—Teflon, Shredded Asbestos, Metallic. SHEET PACKING—Asbestos, Fibre, Cork, Rubber, Synthetic Rubbers, Metallic. O-RINGS, BACK-UP RINGS, V-RINGS, CUPS, U-RINGS, FLANGE PACKINGS—Teflon, Leather, Rubber, Rubber-Reinforced. **GASKETS:** Spiralwound, Molded Teflon, Kel-F, Teflon-Jacketed, Metal-Asbestos, Asbestos, All Metal. **TEFLON SPECIALTIES:** Expansion Joints, Flexible Couplings, Adaptors, Reducers, Rotating Mechanical Seals. **TEFLON & KEL-F STOCK:** sheets, tape, rods, tubing, bars, cylinders, fabricated parts.

U. S. GASKET • BELMONT PACKING

More EQUIPMENT NEWS

Begins on page 160

chined to make a thinner walled section called the corrosive-sensing-area. This end is inserted into chemical processing tank. Other end, extending outside tank, is held into position with fittings and pressure-tight packing.

If inside tank there is the right combination of hydrogen-ions, sulfides, temperature and/or acidic compounds that can penetrate steel and form hydrogen blisters, these blisters will be formed inside the thinner walled section of the device. Hydrogen from blister will show its presence on pressure gage. Operator can then take protective action to retard this action.

Texsteam Corp, 320 Hughes St, Houston 11, Texas

Tube-expanding control

1231 • Electric control for tube expanding is said to assure the same expansion of each tube after metal-to-metal contact regardless of small variations in size of tube and tube sheets. This control is a torque-limiting device designed for use with any standard tapping motor.

The control features a voltage balancer that eliminates need for a voltage regulator by automatically balancing out all outside voltage variables that effect calibration of the control.

Any of three standard tapping motors with built-in reversing gear system and quick-change chucks can be furnished with the control. Full details on request.

Elliott Co, Lagonda Division, Springfield, Ohio

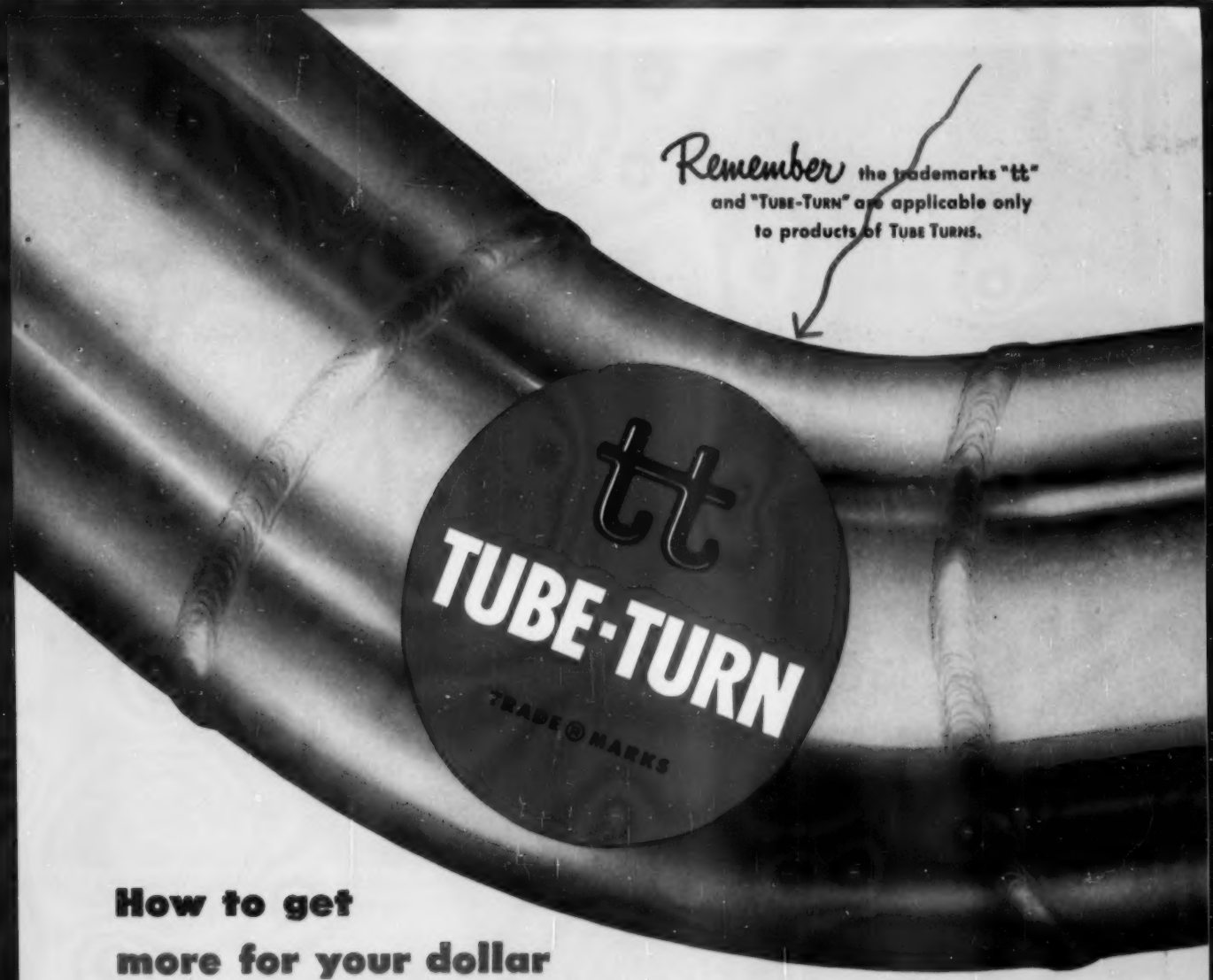
For more data on these items, use post cards p 169. Identify your request with item number.

Mechanical conveyor

1236 • Lightweight vibrating conveyor is built in 12-ft sections and is available in deck widths of 5, 8, 12, 18 and 24 in. Sections may be cut to obtain any odd length. Height from floor is 14 in. maximum. The unit will move materials of good conveyability up to 45 tph.

The drive is totally enclosed and oil immersed. Low maintenance is a result of this feature, according to manufacturer.

The Jeffrey Manufacturing Co, Columbus 16, Ohio



How to get more for your dollar in stainless steel fittings!

When you specify TUBE-TURN* Welding Fittings and Flanges . . . regardless of type, size or material . . . you can be *sure* you are getting *top value.* Manufacturing improvements which we are constantly making assure not only unsurpassed quality, but economies which are passed on to you.

In TUBE-TURN Stainless Steel Welding Fittings, for example:

Recent advancements in our production techniques have netted important savings, resulting in price reductions. Are you taking advantage of these savings . . . plus the extra values described on the next page?

TUBE-TURN Welding Fittings and Flanges are made in U.S.A.
They meet *all* U.S. piping code specifications.

TUBE TURNS LOUISVILLE 1, KENTUCKY

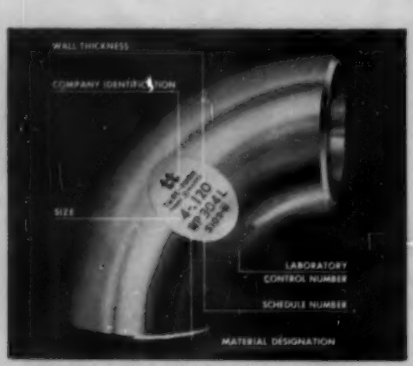
A Division of National Cylinder Gas Company

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Cleveland • Detroit • Chicago • Kansas City • Denver
Los Angeles • San Francisco • Seattle • Atlanta • Tulsa • Houston • Dallas • Midland, Texas

*"TUBE-TURN" and "tt" Reg. U. S. Pat. Off.

EXTRA VALUES

MATCH PIPE for calculated bursting strength.



LONG-LASTING IDENTIFICATION. Lectro-etch markings give complete, permanent information. Fittings have bright, attractive finish.

UNIFORM WALL THICKNESS. Pipe minimum wall thickness tolerance of 87½% of nominal thickness is maintained.

TUBE-TURN*

Stainless Steel Welding Fittings and Flanges offer you these extra values

MEET ALL CODES: ASTM A312 (for material); MSS SP43 and ASA B16.9 (for dimensions); MSS SP25 (marking procedure).

COMPLETE LINE IN STOCK . . . four analyses: Type 304, 304L, 347 and 316. Four wall thicknesses: Schedules 5S, 10S, 40S, 80S.

WALL CHART of dimensions of popular sizes of TUBE-TURN Stainless Steel Welding Fittings and Flanges.

TUBE TURNS, Dept. C-6
224 East Broadway, Louisville 1, Kentucky

Please send me chart TT 730.

*Company Name*_____

*Company Address*_____

*City*_____ *Zone*_____ *State*_____

*Your Name*_____

*Position*_____

Available from your nearby TUBE TURNS' distributor

DISTRICT OFFICES

New York	Detroit	Seattle
Philadelphia	Kansas City	Atlanta
Pittsburgh	Denver	Tulsa
Cleveland	Los Angeles	Houston
Chicago	San Francisco	Dallas
	Midland, Texas	

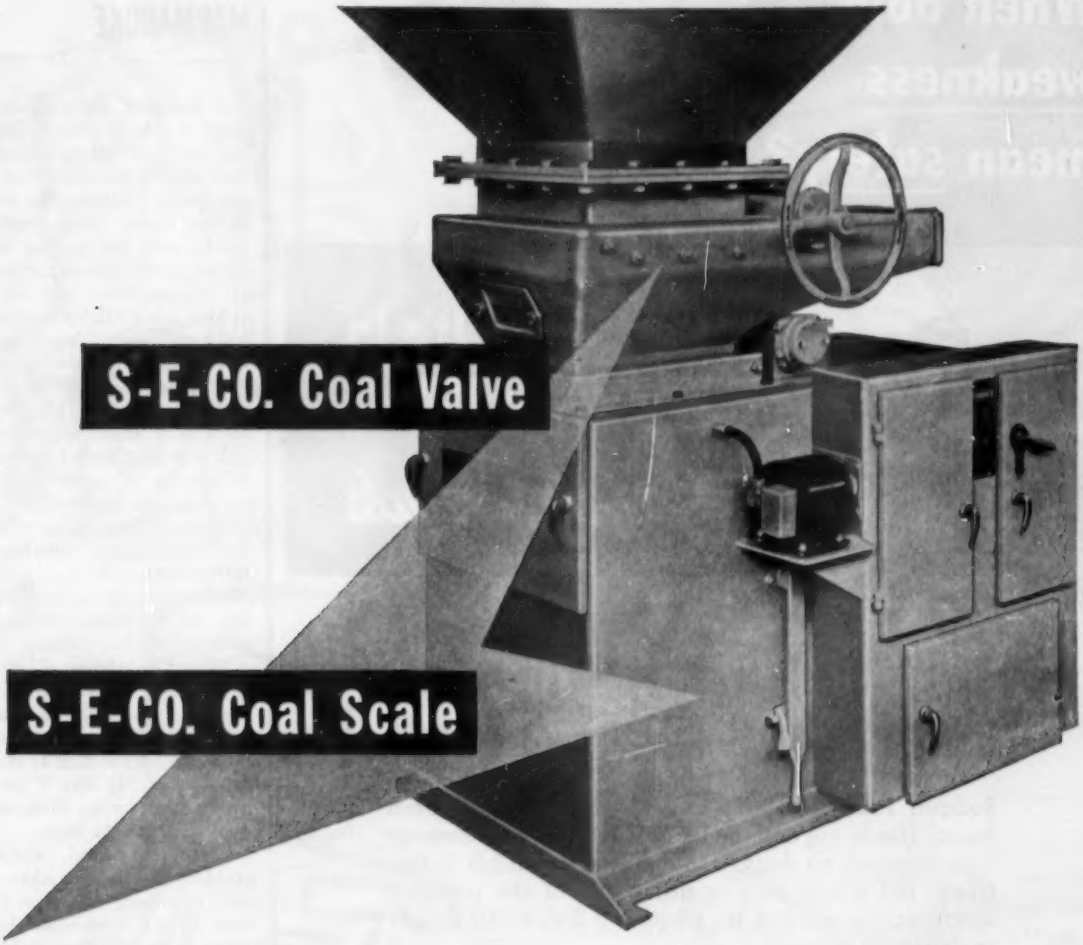
*"TUBE-TURN" and "TT" Reg. U. S. Pat. Off.

TUBE TURNS

A DIVISION OF NATIONAL CYLINDER GAS COMPANY

LOUISVILLE 1, KENTUCKY

QUESTION:



DESIGNED for each other and for Your Plant

. . . that's why you get more value when you buy S-E-Co.

Notice how the valve and scale fit together. The valve outlet forms part of dust-tight slip joint at scale inlet. The scale is designed to allow the valve dust cover to extend over it, not into the aisle where it is an accident hazard . . . and the whole arrangement is not only compact but built to last — and last.

In addition to coal scales and valves, the carefully designed and manufactured S-E-Co. line of products includes the CONICAL Non-Segregating Distributor; Automatic Underbunker Conveyor; Turn Counting and Paddle Type Coal Stoppage Alarms; and all other items required to make a complete, dust-tight and dependable Bunker to Pulverizer or Stoker installation.

For complete information on any S-E-Co. product write:

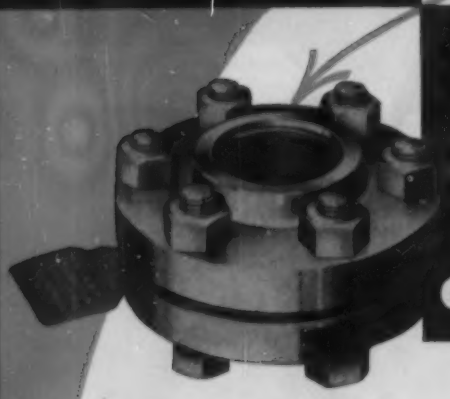
SPECIALISTS IN
BUNKER TO PULVERIZER AND
BUNKER TO STOKER EQUIPMENT

STOCK Equipment Company

745-P HANNA BLDG., CLEVELAND 15, OHIO

QUESTION:

When does weakness mean safety?



ANSWER:

Only When It's In BS&B *Safety Heads*

Safe, Sure Protection Against Overpressure within Pressure Vessels

Sudden Pressure, Safe Relief—that's what BS&B Safety Heads are designed to give. There's no damage to equipment, no danger to employees. BS&B Safety Heads fail within plus or minus 5% of the pressure specifications *you* give us, whether 5 lbs., 40,000 lbs., or anywhere in between.

Tested to Destruction, BS&B Safety Heads are pre-proved at the factory. Rupture Discs, selected at random from each lot, are put under pressure until they fail. If each one tested does not break within 5% of the rated pressure, the entire lot is discarded!

A Full, Pipe-Sized Opening results when a BS&B Safety Head Rupture Disc blows out. You can use them for primary or secondary relief where maximum protection is needed, or to back up a relief valve when the contents might prevent the valve from functioning properly. Whether *your* pressure applications are for air, gas or liquids—bland or corrosive—you can count on BS&B Safety Heads for safe, certain relief.

Write for Complete Catalog

Whatever your pressure applications, there's a BS&B Safety Head for you. Write today for the Safety Head Catalog, or ask your BS&B Man. There's no cost or obligation for a complete analysis of your pressure safety requirements.

SAFETY BS&B HEADS OUR 50TH YEAR

BLACK, SIVALLS & BRYSON, INC.

Safety Head Division, Dept. 2-Q12

7500 East 12th Street Kansas City 26, Missouri

MARMADUKE

Continued from page 148

that province. He controlled the lion's share of a large office building and had the top floor all to himself, with his own private elevator. That well-heeled guy had a reputation for staging mixed parties in his fancy penthouse apartment. And his parties were always called on the spur of the moment.

"His penthouse was the show place in that town. Being invited to one of his parties sent a guy's stock way up. But the gay old boy, who always got his brainstorms suddenly, never sent a written invitation. Instead, he called his friends minutes before the party was to begin. They knew a good thing, so usually came on the double and asked no questions.

"Ground floor of his building had a fancy restaurant, complete with hard refreshments. It was always on the alert to cater to our hero's famous parties. So the waiters become known locally as 'Mr Big's minute men.'

"Day I'm talking about the outside temperature nose-dived to minus 20 degrees. And relative humidity was less than 20 percent. Old party-boy suddenly got the urge to throw a super get-together. It was 7 pm and most people were happy to be at their firesides on that cold night.

"Trouble started when Mr Big grabbed the phone to make a few dozen calls to the top names on his list. We were having trouble in the area ourselves about that time, so he had to use a second phone in his apartment that had a connection with the lighting circuits. But he couldn't make his calls because he got a stinging shock every time he touched his phone.

"It was getting late and Mr Big was afraid his party would flop before it started unless he could call his friends. But that stinging phone got the old boy boiling and his voltage was zooming by the minute.

"Service man on duty at my office humored Mr Big by sending him not one, but two service men, straight from their homes. By then old party-boy was all steamed up and he tore into my men as soon as they got inside his joint. But at 7:30 pm his phone was still hot and the place was popping with tirades while my boys got nowhere near finding the trouble. They couldn't do anything so they sent our general manager an SOS at his home.

"Because Mr Big was our chief stockholder, the manager sent his stooge after me. I was at the Cheerio Bar around the corner, where all day I had been mighty busy, looking for a short circuit. I had also taken care of a blown fuse or two. Being disturbed,

Are those all the ashes for the day?

That's all! We're using a low-ash coal now. The analysis shows only one-half as much ash as the coal we had been using, and there is a great deal less unconsumed coke on the refuse.

But don't we have to pay more for this kind of coal?

Yes, we may pay more at the mine, but it costs us less delivered. Remember we used to pay freight on all those ashes and then pay to haul them away. And because there is so much more usable coal in each ton, we use fewer tons.

Who showed us how to make this saving?

A C&O fuel service engineer gave us the facts and figures to show that this higher quality coal would really cost us less in the long run, and our experience has proved he was right. I am convinced now that you can't buy coal on price alone. It pays to get the advice of a competent combustion engineer and to pick the coal that will do the best job under your own set of conditions.

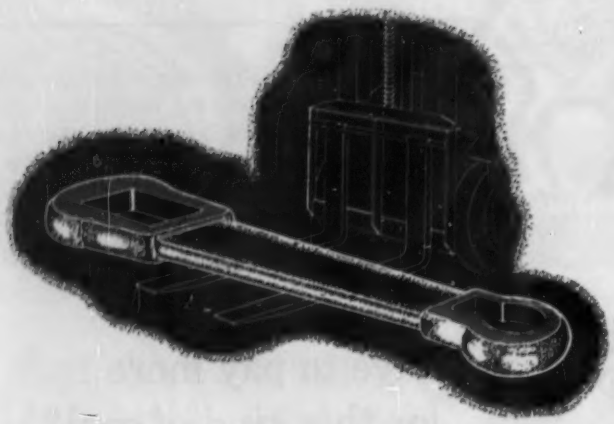
P.S.

There's a lot more to buying coal than the cost per ton. Why not contact coal producers on the C&O to solve your particular fuel requirements, or write to: R. C. Riedinger, General Coal Traffic Manager, Chesapeake and Ohio Railway Company, Terminal Tower, Cleveland 1, Ohio.

Chesapeake and Ohio Railway

WORLD'S LARGEST CARRIER OF BITUMINOUS COAL

Worn? Mismachined?



VANDERLOY* is the answer.

Connecting rods, power cylinders, shafts, rods—i.d. or o.d. surfaces—all can be restored to design dimensions by the application of VANDERLOY.

VANDERLOY* **an electrolytic iron that bonds atomically with most ferrous metals, aluminum, copper, nickel and their alloys.**

Write for additional information on this NEW reclamation service.
Dept. DR-2, VAN DER HORST CORPORATION, Olean, N. Y.

VAN DER HORST

TERRELL, TEXAS
OLEAN, NEW YORK
LOS ANGELES, CALIFORNIA**
HILVERSUM, HOLLAND

*Patents applied for

**SpurTan Engineering West Coast Licensee

MARMADUKE

Continued from page 190

just as I was about to find that short circuit down in the liquor vault, got my Irish up.

"So I called the manager to find out what all the shooting was about. He asked me to straighten things out in Mr Big's apartment but warned, 'Whatever you do, keep the old boy's temperature down.'

"When I showed up, Mr Big was popping his safeties, blowing a gasket and stripping his gears, all at the same time. And my two service men were taking it all because they had instructions to humor the old goat. I could see they were ready to blow their stacks any minute, especially because they were being raked over the coals about a condition beyond their control.

"After introducing myself I broke out some flashlights, then had all the circuits feeding that area cut off. That helped me put my finger right on the trouble, and no mistake. I decided that because of atmospheric conditions, when Mr Big shuffled his feet for a short distance over his thick Persian rug, he generated enough static electricity to jump to ground when he touched his telephone. I learned the spark-overs were from three to four inches long. So the gay party-boy naturally had a reason for being upset. Besides having his last-minute plans spoiled, he thought we were trying to electrocute him and then play dumb by not doing anything to help him.

"When I explained the cause of his trouble, he really let go a blast. 'Do you take me for a complete idiot, sir?' he yelled, growing pink around the gills. 'First you try to shock me to death and now you insult my intelligence by telling me those sparks are caused by *me*. Well now, that is really rich, I must say, I *must* say.'

"I could see that reason would get me nowhere. This was a case of putting on a show so he could see for himself. They say one picture is worth a thousand words, and a demonstration is worth a thousand pictures. Now I'd see if that saying was really true or just so much bilgewater.

"I remembered my first lesson in static electricity in a paper mill a few years before. At the mill's finishing end I once saw sparks jump a foot or more in cold and humidified atmosphere. Maybe I could put that idea to use now.

"First I had the circuits switched on again. Then I asked Mr Big to turn on one of the gas jets, but not to light it, in his large living room. He was skeptical but he saw I meant business. Then I started shuffling my feet along

6 STAR FEATURES

years ahead!

A VERTICAL SPLIT CASE PUMP

B & G SERIES 1510

TYPE B CENTRIFUGAL PUMP

. . . with balanced loading of impeller and bearings . . . handles loads far in excess of those produced by any pump and motor combination! Easily serviced without breaking pipe connections!

1. **Leak-proof Mechanical Seal.** Features the exclusive, harder-than-glass B & G "Remite" insert. This Seal construction has enabled nearly two million B & G Pumps to make an amazing record for failure-proof performance.

2. **Hydraulically Balanced Impeller.** Balancing chamber and pressure relief holes in the impeller reduce thrust to a minimum, lengthening pump life.

3. **Solid-type Volute with Support Foot.** Can be left in pipe line when servicing pump —rugged construction absorbs piping strains.

4. **Removable Bearing Frame.** Complete bearing frame, including seal and impeller, can be removed without disturbing piping or motor leads. The bearing frame is replaceable and interchangeable on all sizes.

5. **Anti-Friction Roller Bearings.** Timken Bearings handle thrust and radial loads for smoother, quieter, more efficient operation.

6. **Oil Lubrication.** No messy, undependable grease cups—circulating oil lubrication assures positive protection to bearings. Oil level indicator permits visual check.

STOCK PUMPS!

Selected sizes of B & G Series 1522 and 1531 Centrifugal Pumps are stocked at the factory for immediate shipment. Capacities to 225 GPM, heads to 140 ft. Send for Price and Selection Catalog.

BELL & GOSSETT

COMPANY

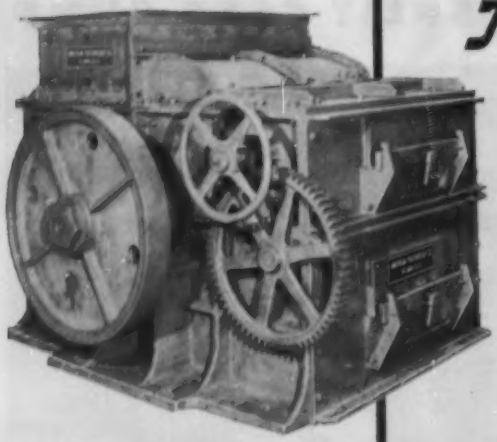
Dept. ED-36, Morton Grove, Ill.

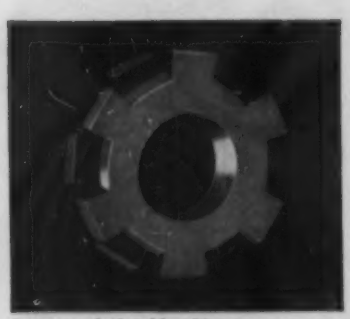
Canadian Licensee: S. A. Armstrong Ltd., 1400 O'Connor Drive, Toronto, Canada

BETTER COAL CRUSHING CONTROL BECAUSE IT'S BUILT BETTER . . .

American

ROLLING RING COAL CRUSHERS



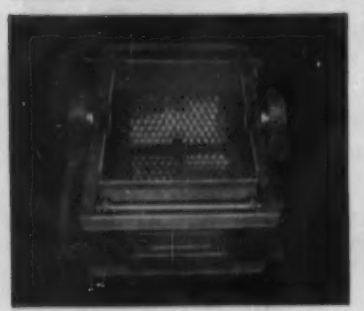


1 Patented Shredder Ring

American-originated feature that splits coal instead of smashing it—for uniform sizing, minimum fines. Result: Americans run at slow speeds, with savings in power and maintenance. No cams, shear pins, toggles.

2 Heavy-Ribbed Steel Frame

Bearing pedestals are cast integrally with lower side frames. Sectional design for easy dismantling . . . abutting joints accurately machined and bolted together for dust-tight fit.



3 Completely Lined Crushing Chamber

Heavy, renewable liners . . . sectional for easy plate-at-a-time replacement . . . engineered to offer life-time protection to the frame.

4 Complete Accessibility to Adjustment and Parts

All adjustments external—even with crusher in motion. Rotor easily reached by removing top section. Rings readily reversed or replaced. Liners quickly reached, too, for periodical inspection.

WRITE for Coal Crushing Bulletin

American PULVERIZER COMPANY

1349 MACKLIND AVE. • ST. LOUIS 10, MO.

MARMADUKE

Continued from page 192

the rug for about ten feet, with my finger pointed to the open jet. Soon as I got about four inches away, a spark jumped from my finger to the jet and lighted the gas. Our problem child's eyes popped. When he got his breath his eyes blinked and he finally said, 'Now I'll try it.'

"I blew out the gas. When his finger lit the gas after shuffling his feet, he roared like a kid. He was having fun. 'By jingo,' he yelled, 'This is really jolly, Mr Surfaceblow, this is really *jolly*, eh, what? And this is the most convincing argument I ever heard—I mean saw,' he laughed. Then his face sobered up and he asked, 'But this still doesn't solve my problem, you know, old fellow.'

"'Sure it does,' I assured him. I had him send his butler down to the drug store for rubber gloves. A few minutes later our important stockholder was on the phone, rounding up his boy and girl friends for the party.

"But that wasn't the end," wound up Marmy, getting back to his bottle. "Mr Big let my two service men go, but not me. He put my name at the head of his party list. And by the time the other guests arrived, the two of us were really burning up the place, as well as lighting the gas with our fingers. That was one Christmas party I never forgot. And all because I proved a point to a hard-to-convince guy—by using a show instead of trying to cram words down his throat he wouldn't have understood or believed."

At this point Marmy worked up a 28.5-inch vacuum on his cargo pump and turned bottoms up on his bottle of Sandpaper Gin. After bunkering his forward and after peaks, his deeps and his double bottoms, he topped off his settlers and roared, "Bilgewater on the past. Merry Christmas and a happy 1956 to all POWER readers."—*SME*.

EDITOR'S NOTE: *Same goes from us, too.*

Marmy's Mailbox

'Tis here you exchange blasts with the old boy

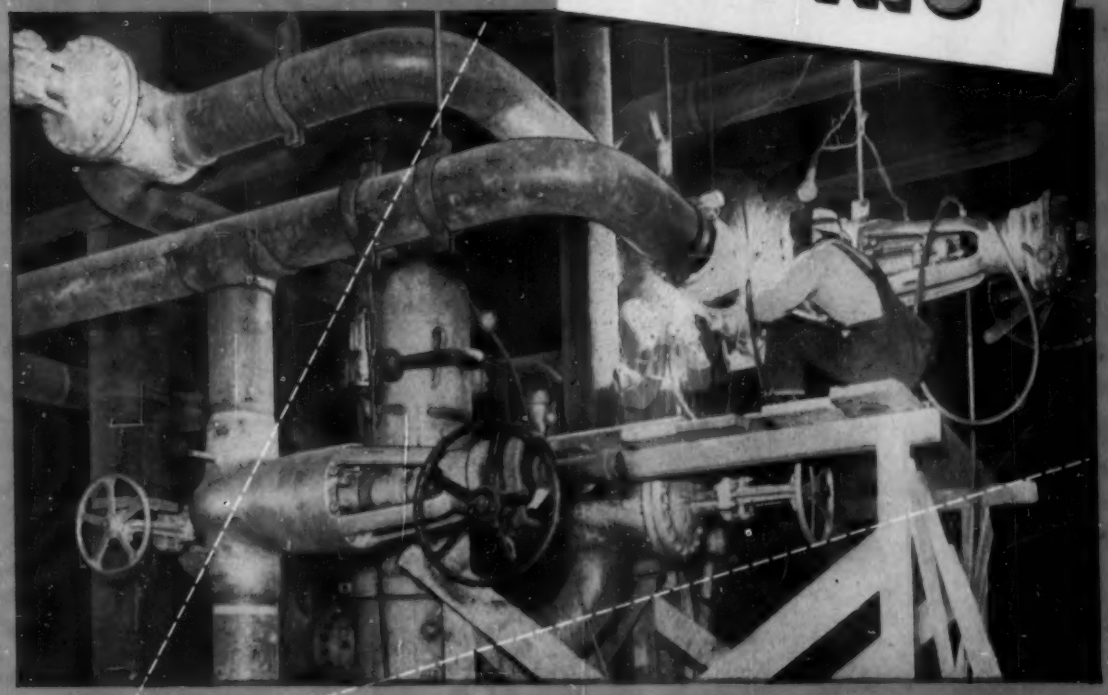
IMPORTANT LESSON

"Marmy puts her astern" in December is tops. He puts over a very important lesson to business people and engineers. Hope your readers will cash in on it.

Talairon, P. I. L B VILLARTA

THERE IS

MUCH MORE TO MIDWEST PIPING



THAN MEETS THE EYE

Here you see carefully qualified Midwest welders erecting the boiler feed piping in a new public utility steam-electric generating station. What you don't see are the many other highly skilled men who contribute to the high quality of Midwest Piping.

First, there are the expert piping engineers who prepare the job for fabrication. They simplify the field work and make sure the difficult operations are done in the shop. And they often make suggestions that improve the design and reduce the cost of the piping.

Then there is the experienced shop organization (working with the most modern equipment) that delivers to the field subassemblies which are accurate in dimension, correct in alignment, thoroughly cleaned, heat treated when necessary, carefully inspected and tested . . . ready for erection at lowest cost. Both the shop and field supervisory personnel have come up through the ranks and know every phase of the operations . . . how to assure the customer the most for his money when he buys Midwest Piping.

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Main Office: 1450 South Second Street, St. Louis 4, Mo.

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MIDWEST **PIPING FABRICATION and CONSTRUCTION**

OFFERS YOU MANY BENEFITS

Get
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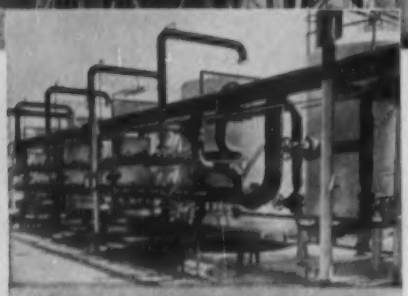
HARDNESS BOILER FEEDWATER
—at LESS COST



Top photo shows new outdoor hot lime-zeolite softener installation in a Southern refinery. Five Nalcite HCR ion exchange units (lower photo) have output of 470,000 gallons of zero hardness water between regenerations.

with
Nalcite® (DOWEX®) HCR
HOT LIME ZEOLITE TREATMENT

● Start with the simplicity of operation . . . add the low operating costs of hot lime-zeolite softening . . . all made possible by the outstanding high-temperature performance of Nalcite HCR in the zeolite softeners. Results: Zero hardness water, from virtually any raw water source, with a minimum of testing and control required. See your water treating equipment manufacturer for details on new or conversion hot lime-zeolite treatment for your plant . . . and for top softener efficiency, specify Nalcite HCR.

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Nalco® PRODUCTS

When you use Nalcite resins, you take advantage of Nalco's long and broad experience in water and process technology.

DIESEL SMOKE

Continued from page 121

advance, as explained, will probably make matters worse. Increasing the cetane number of fuel normally improves cold smoke. But if taken too far it will make the hot smoke worse. Same is true of compression ratio increase or enjine-jacket temperature. In practice both hot and cold smoke usually aren't affected by change of cetane number in normal range of 40 to 60.

Diagnosis. When you run into a smoking engine, your first step is to check the injection system to find if it's in good condition. Also, make sure the engine is properly timed and balanced and load isn't excessive. Check for contamination. If in doubt, check the run with a known good-quality fuel.

If smoke is more pronounced at low-load end of range, trouble is probably cold smoke due to excessive ignition delay. If smoke rise is worse at full-load end, then sluggish combustion may be the trouble. You can make check test by running engine on a mixture of 50-50 regular-grade gasoline and a good grade of high-cetane No. 1-D gas oil. If sluggish combustion is trouble, smoke should improve. But if cold smoke is from ignition delay, it will get worse.

Summary. If your diesel smokes, make sure that injection system is in good condition and that the cylinders are balanced within reasonably close limits. Also, make sure fuel isn't contaminated. Attention to these points will clear up most cases of engine smoke —if they are not caused by gross overload. If it doesn't, establish whether hot smoke or cold smoke is responsible.

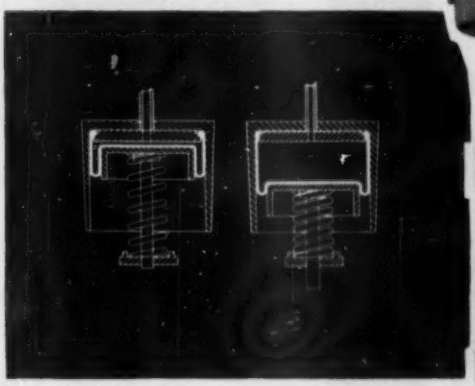
If trouble is due to hot smoke, try: (1) preventing gross overload, limiting pump-rack travel as necessary and practicable (2) reducing engine temperatures (3) a lower cetane-number fuel (4) a lower compression ratio, if this can be done without poor starting; some adjustment to injection timing may be necessary. These four measures are about all an operator can take. If hot smoke still persists, he can reduce its ill effects by using a fuel with as low an ash-and-sulfur content as possible.

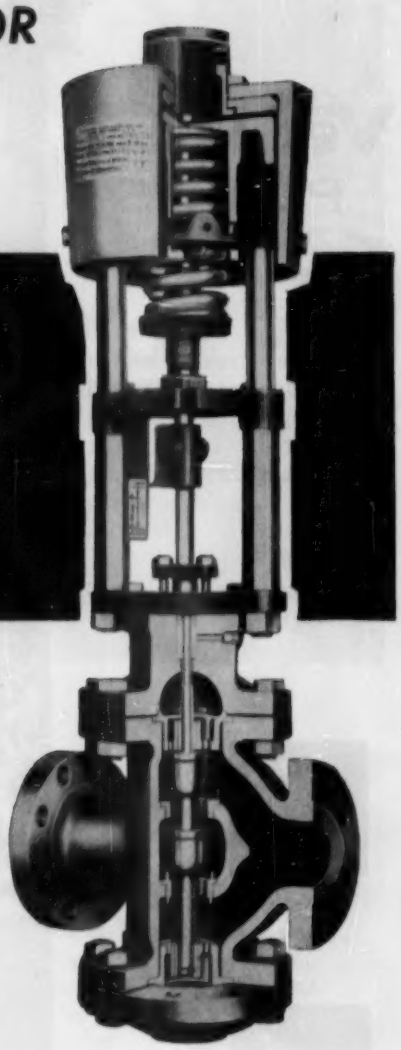
If cold smoke is the trouble try: (1) advancing injection timing a little (2) raising engine's operating temperature (3) a higher cetane fuel (4) a higher compression ratio taking care not to produce excessive firing pressures (or hot smoke) at full load, and make sure valves don't strike piston (5) learning to live with or sending engine back. There are more tricks, but they involve changes to combustion chamber and head design of engine.

FOR FLUID CONTROL

THE NEW FOSTER CONTROL VALVE WITH ISOFORCE ACTUATOR

GIVES YOU MORE POWER WHEN YOU NEED IT...



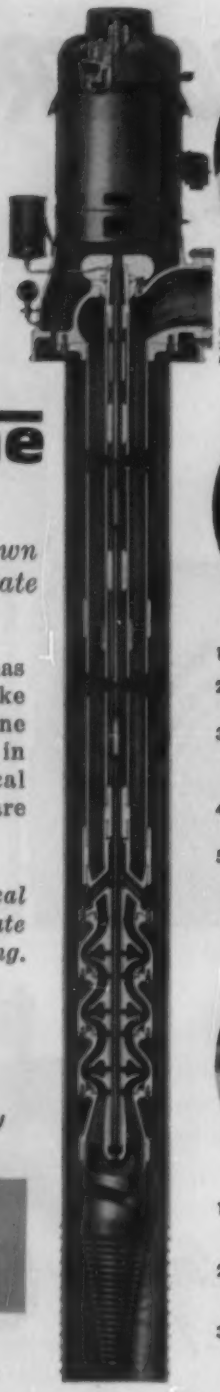


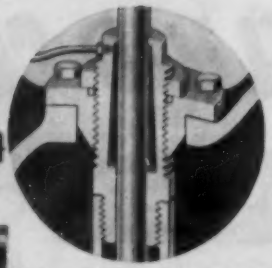
...with the Foster Bellofram construction, no force is lost at end of the stroke where spring compression requires the maximum force. This assures linearity of instrument and stem positions.

These new control valves are available in sizes starting at ½" with materials and end connections to suit operating conditions.

For complete technical information, ask for Bulletin CV-1

FOSTER ENGINEERING COMPANY
835 LEHIGH AVENUE UNION, N. J.
AUTOMATIC VALVES · CONTROL VALVES · SAFETY VALVES · FLOW TUBES





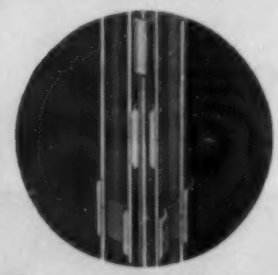
This easily accessible assembly provides means of putting tension on oil tubing, making a rigid, taut, non-vibrating bearing and shaft enclosure.

Verti-Line PUMPS

are economical to own — economical to operate

Feature after feature has been designed to make the Verti-Line Turbine Pump today's best buy in vertical pumps. Typical construction features are illustrated.

Whatever your vertical pump needs, investigate Verti-Line before buying.

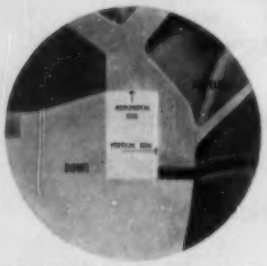


1. Butt-joint column pipe is usually furnished in 10 ft. lengths.
2. Sleeve type pipe couplings are standard. Flanged type also available.
3. Reinforced rubber enclosing tube supports assure alignment of oil tube and are spaced as specified by Layne & Bowler engineers.
4. Extra long, special alloy bronze bearings are spaced at 5 ft. intervals.
5. Lineshaft is of highest quality steel, turned, ground and polished. Tested for accuracy within .002 in. High tensile strength assures greater safety.

in all industry

on the farm

for the city



1. Either radial vane or mixed flow type impellers are supplied depending on service and conditions.
2. Oversize pump shafts eliminate deflection, whip and vibration, resulting in longer bowl life.
3. Perihedral seal combines vertical cylindrical and horizontal surface impeller sealing. Shaft stretch due to pressure change is not critical, because of vertical cylindrical seal. However, adjustment for wear to restore original capacity is easily accomplished by means of an adjusting nut in the top of the driver that brings into action the horizontal part of the Perihedral seal — an exclusive Verti-Line feature.

Send for your free copy of our new booklet, "Pumps For Sale." Ask for Bulletin O-125

Verti-Line Pumps are the exclusive products of

LAYNE & BOWLER PUMP COMPANY

general offices and main plant

2943 VAIL AVENUE • LOS ANGELES 22, CALIFORNIA

More ARGUMENTS

Begins on page 142

bles get into the pump, they lower the specific gravity of the water. Then head produced by the pump falls. If it drops below boiler pressure, which will probably be higher than normal, water flow through the pump will stop. Internal heat losses may rapidly overheat the pump and cause damage. In addition, boiler will be without water supply.

Size of the boiler-feed-pump suction lines can have a variety of effects depending on arrangement. If pipe is very small, friction drop causes increased flashing and the high velocities make all steam bubbles flow down into the pump.

With a liberally sized suction header and pipes, steam bubbles can conceivably travel upward to the storage tank. Also, the small friction loss causes a minimum of extra flashing in suction lines. The longer time required to get cooler water into the suction line from the storage tank is an offsetting factor. This could have an adverse effect, since water would experience a greater pressure drop over a longer time, and could thus release a greater amount of flash steam.

General arrangement and type of associated equipment in the plant might determine whether under-sized or liberally sized suction piping is most satisfactory. But our experience tends to favor liberally sized suction lines.

D C SWIFT *Sydney, Australia*

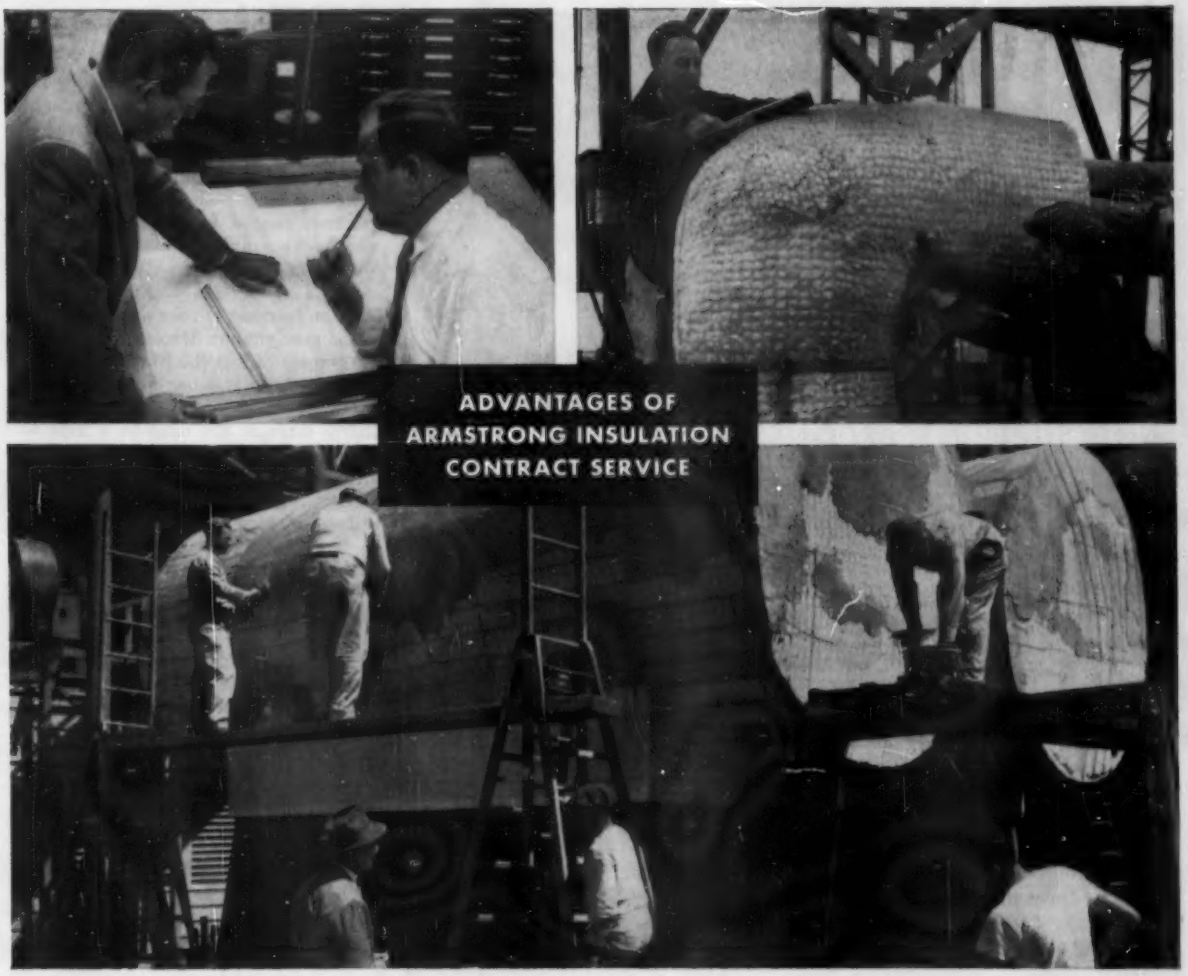
FLUID COKE

Continued from page 105

acquaint operating personnel with solid-fuel firing. A minor adjustment was made to the feeders to enable them to handle fluid coke.

Mills supplying this boiler were rated at 16 tons per hr when handling 91-Hardgrove 5%-moisture coal and grinding it to 82% through 200 mesh. At the same fineness, mill capacity was about 6 tons per hr when handling coke. This compared favorably with the original derating estimate of 2.5. Lower curve, Fig. 1, shows results of tests on these mills.

Reduced-load tests on this boiler were made with coke providing 52 to 64% of the total heat supplied. Mills produced a coke of 46 to 90% through 200 mesh. Full-load runs were made with coke supplying 17 to 52% of the total heat provided, with about the same range of fineness. At higher coke loadings, fineness from mill decreased and unburned coke to the precipitators increased. While unburned coke to the



ON-THE-JOB SUPERVISION . . . *trained people oversee your job from start to finish*

A good way to avoid delays on a construction project is to plan the job carefully—then provide the type of supervision that will make the plan work. Armstrong makes every effort to execute insulation contracts that way.

When you buy insulation work from Armstrong, the sales engineer is your contact with the Armstrong organization. He remains your contact until the job is completed to your satisfaction. Working with him is a construction superintendent who arranges material deliveries and labor schedules. Installation is by skilled mechanics under the supervision of a trained foreman.

No matter where your next insulation job may be, you can depend on Armstrong's ability to perform. A nation-wide network of 42 offices provides a full line of high- and low-temperature insulations, as well as the technical assistance of qualified engineers. The facilities of the Armstrong Research and Development Center are also available to help with special problems.

Get full details on the many advantages Armstrong's Insulation Contract Service offers you by calling your local Armstrong office or writing to Armstrong Cork Company, 2012 Riggs Avenue, Lancaster, Pennsylvania.

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*TRADE-MARK

Vast power projects throughout the world—more than seventy in all—attest to The Kuljian Corporation's reputation as SPECIALISTS IN THE POWER FIELD. These power plants, with capacities ranging from 2,500 to 240,000 KW, represent a total investment of over half a billion dollars.

No matter what type of power project you are planning . . . be it steam, hydro, or diesel . . . Kuljian's wealth of practical experience, backed by a complete staff of internationally recognized engineers, can serve you quickly, economically, and efficiently to meet your specific requirements.

Next time *you* need outside help, why not contact a Kuljian engineer for preliminary consultation. He will be glad to provide the help you need, anytime . . . anywhere.

ACTUAL ON-THE-JOB REPORTS are continually received at Kuljian headquarters. From these reports, easy to read case histories are developed into articles that are published by editors of leading magazines.

If you are interested in knowing more about us . . . how we work, what we have done for others . . . your request for literature will be most welcome.

The Kuljian *Corporation*

engineers • constructors

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BRANCH OFFICES THROUGHOUT THE WORLD

FLUID COKE

Continued from page 198

precipitators was high, it was not felt to be excessive. Based on the reactivity of the precipitator samples collected, it is believed the material could be reinjected and successfully burned.

At full load, boiler efficiency during the tests ranged from a low of 78.8% when coke supplied about 37% of the heat to a high of 86.4% when coke supplied about 17% of the total heat. With an increase in coke fineness, losses to the precipitators decreased. Based on the percent of total fuel fired, unburned coke to the precipitators ranged from a low of 2% with a coke fineness of 88.0% through 200 mesh to a high of about 10% when firing coke of 51% through 200 mesh.

After burning about 500 tons of coke without noticing any detrimental effects on No. 26 boiler, it was believed desirable to test a newer and larger boiler —No. 1 boiler, installed in 1947. This boiler is a B&W 900,000-lb-per-hr radiant-type unit rated 1500 psig and 1000 F at the superheater outlet. Over-all heat-release rate is about 22,000 Btu per hr per cu ft. Boiler is equipped with air heaters, economizer, attemperator and electrostatic precipitators. Pulverized fuel is supplied by three Foster-Wheeler Type D-5B ball mills, each feeding four B&W circular burners equipped for coal, oil or gas firing.

Combustion in this unit appeared much better than in the No. 26 boiler. Fig. 1 shows comparative grinding tests. Full-load boiler efficiencies ranged from a low of 87% when coke supplied 17% of the total heat to a high of 88% when coke supplied 45% of the total heat. Precipitator losses were considerably less than with No. 26 boiler.

The circular burners of No. 1 boiler appeared to be better suited to coke burning than the intertube burners of No. 26 boiler. Moreover, the absence of a slag screen in No. 1 boiler seems to have contributed to the better combustion conditions experienced.

It appears that the percent of volatile matter in the coke burned in No. 1 boiler was in general higher than that burned in No. 26 boiler. The volatile matter ranged from 6 to 8% for the No. 26 boiler tests whereas it ranged from 7 to 14% for No. 1 boiler tests.

In all tests at this station it was necessary to maintain an auxiliary fuel flame at each coke burner to insure proper combustion. When the auxiliary fuel was removed from the burner, the ignition point of the coke moved well out into the furnace. In some cases it was impossible to tell where ignition was taking place even though there was no apparent change in the appearance of the furnace in the area above the flame. Insufficient quantities of coke

Traveling Stocking and Reclaiming Coal Handling Tower OF WELDED DESIGN

a Mead-Morrison development

All connections in the main structure of this tower, both shop and field, are welded. The cantilevers employ riveted connections and are fastened to the main structure by means of rivets.

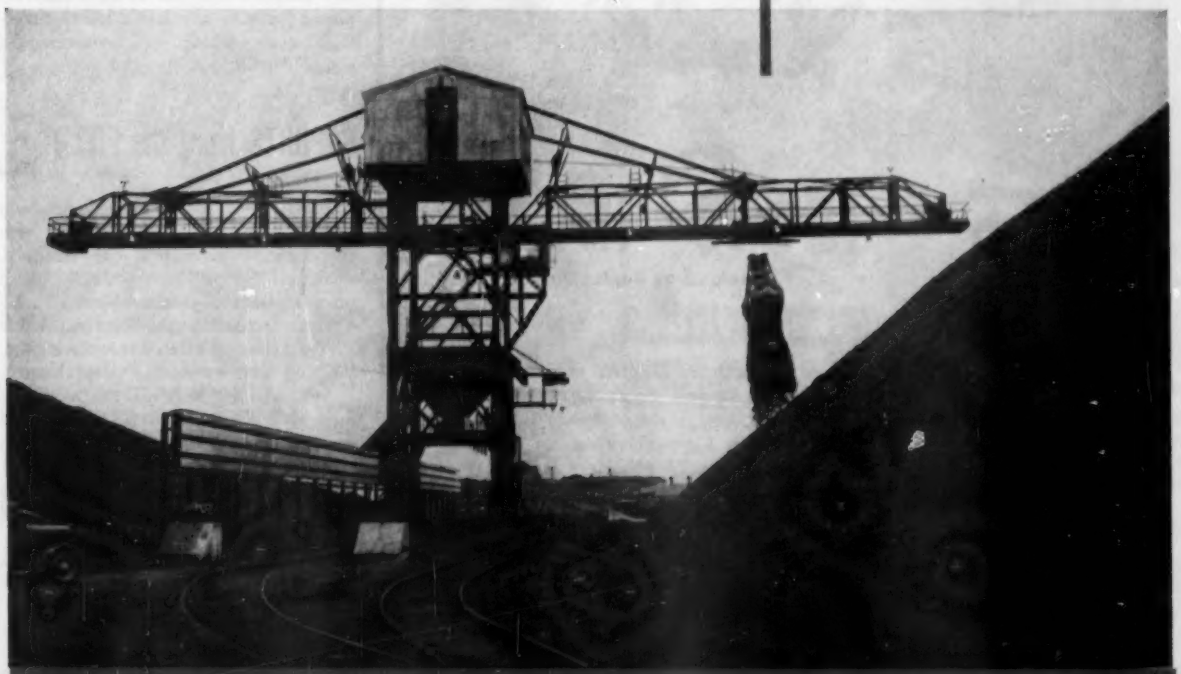
This modern design is typical of Mead-Morrison pioneering in developing stronger and more economical material-handling equipment. Write for complete information on Mead-Morrison Towers and Bridges for coal, ore and other materials.

Coal is brought to the plant of a large West Virginia steel mill in cars which dump into a digging pit alongside the Mead-Morrison tower. Unloading of the cars is aided by a car shakeout suspended from the side of the tower.

The tower digs coal from the trough and delivers it to the near-side stocking pile at the rated capacity of 915 tons per hour, and to the far-side stocking pile at the rated capacity of 610 tons per hour.

The tower also reclaims coal from the storage piles to the receiving hopper in the tower at the rated capacity of 765 tons per hour from either pile.

Included in the Mead-Morrison equipment are a 6½ ton lightweight grab bucket and automatic rail clamps to protect the structure in a high wind. Adjustable voltage is used for the hoist, close and trolley motions, and constant voltage for the propelling motors.



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More than a dozen different arrangements of valve designs and operating methods are available to you in the complete Everlasting line of boiler blow-off valves for operating pressures up to 600 psi. Here is a range of selection from which you can get exactly the combination you wish.

For half a century, Everlasting Valve designs have been proving their effectiveness, reliability and durability—the kind of service you need for boiler blow-off. Each design fully meets ASME Code requirements. **WRITE FOR BULLETIN**

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EV284

FLUID COKE

Continued from page 200

were burned at Essex Generating Station to determine what effect coke firing would have on boiler maintenance.

These tests showed that electrostatic precipitators will function properly when handling fluid coke. Other large-scale tests indicated mechanical precipitators are somewhat more efficient handling fluid coke refuse than when handling flyash.

Much additional information, yet to be procured, cannot be obtained until a steady supply of fluid coke is available. Based on these tests, however, Public Service has contracted for the entire output—about 170 tons per day—from the fluid-coking unit recently completed at Esso Standard Oil Company's Baltimore refinery.

In addition to the Public Service work, other combustion tests were run by Babcock & Wilcox Co and The Riley Stoker Corp. Test work is presently being conducted at the Oleum Steam Plant of the Pacific Gas and Electric Co and other tests are being contemplated.

Based on the laboratory and full-scale test programs, it can be said that the power industry now has a fourth fuel—fluid coke—which can economically compete with coal, gas and oil.

REPORTS from the FIELD

Begins on page 154

research and development program whose goals are to (1) produce synthetic mica in forms that will eventually serve all the critical markets where mica is used today and (2) evolve modern mechanized methods to supersede present laborious hand processing associated with producing natural mica.

At first, the bulk of the synthetic mica will be pulverized and bonded with electrical glass to produce *Supramica* ceramoplastic, an electrical insulation material said to withstand the effects of nuclear radiation and 1000 F temperatures.

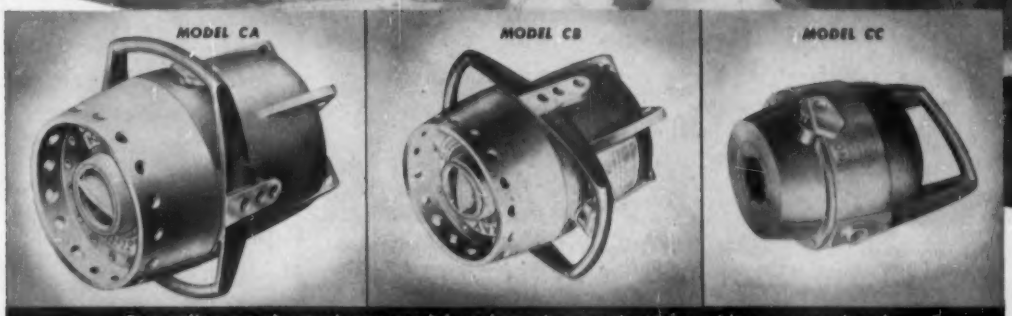
Sargent & Lundy announce formation of atomic group

► SARGENT & LUNDY, Engineers, Chicago, have announced formation, in association with a number of public utility companies, of the Atomic Power Engineering Group. The organization will devote itself to detailed analysis of various reactor designs, technical characteristics, operating problems and suitability for application to power systems.

Companies represented at the first meeting were: Central & South West

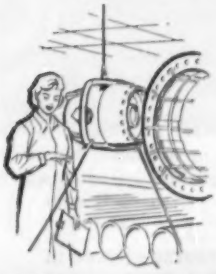
M&T presents the KEL-RAY® Projector*

A safe versatile tool for Radiography with gamma rays . . .



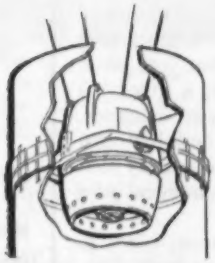
Depending on the projector model and service requirements either encapsulated Cobalt 60, Cesium 137 or Iridium 192 is used as the gamma ray source.

NON-DESTRUCTIVE INSPECTION and TESTING



SAFE

KEL-RAY projectors have extremely low radiation leakage. . . so low they can be shipped and stored without additional shielding. They are tamper, fire, and shock proof. Operated under prescribed procedures, leakage is below the AEC limit.

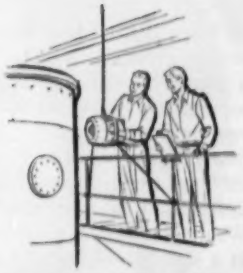


VERSATILE

A single set-up can produce either spot, doughnut, or hemisphere panoramic radiographs. Thick steel sections can be radiographed; sensitivity is so great even incandescent lamp filaments have been radiographed with a KEL-RAY projector.

CONVENIENT

Designed for field or shop use, the smallest model can be carried by hand—largest is transported and positioned speedily with standard equipment for materials handling and rigging.



ECONOMICAL

Initial and operating costs are low. No delicate parts to pamper or adjust . . . no expensive electrical power source required. Minimized overall set up and exposure time provide further savings.

Each of the three KEL-RAY Projector models is a portable, powerful, shielded, self-contained source of penetrating radiation for non-destructive inspection in maintenance, construction or quality control. There is a KEL-RAY Gamma Ray Projector that can improve your operations —save you time and money! Write for detailed literature.

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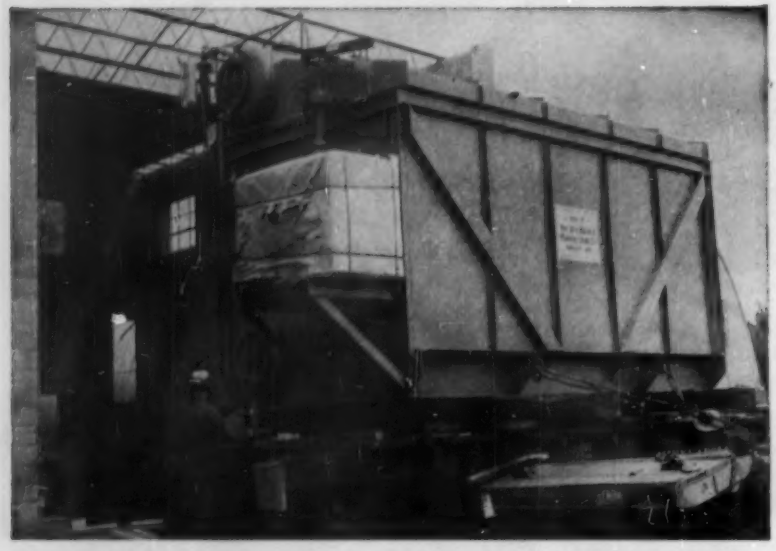


In the photo above you can see how easily a Bros Packaged Watertube Boiler enters your power room. It requires no costly foundations or accessories. It can be lifted or skidded into place. Where clearance is a problem, a Bros unit can be shipped knocked-down for quick assembly at the site.

New savings in steam generation with BROS packaged boilers

● Since the modern Bros Packaged Watertube Boilers were introduced, a steadily increasing group of customers has marveled at their efficiency and true economy. Designed to fit a variety of plant operations in the medium steam capacity range, these units bring many of the larger Bros Watertube boiler advantages to you in a simple, compact "package."

For example, you'll find a vertical self-cleaning arrangement of tubes and baffles to which soot can scarcely cling, helping to promote rapid, effective heat transfer. Cross section is small, making for low head room and shorter length and width. Enclosure casing is gas-tight. What you get is complete combustion, a quick response to fluctuating load demands, low cost operation, and low cost maintenance. Before you specify your boiler, check these economical new Bros units!

Capacities range from 4,100 to 30,000 lbs. of steam per hour. Gas, oil, or combination fuel option. A choice of manual, semi-automatic or fully automatic control is available, to meet your requirements.

WRITE FOR YOUR PERSONAL COPY OF THIS NEW CATALOG

This colorful catalog contains design features, construction details, drawings and specifications of Types W-1, W-2 and W-3 Bros Packaged Boilers. Get your copy for reference or file now!

POWER DIVISION—WM. BROS BOILER & MFG. CO.

1057 Tenth Avenue S.E. BROS Minneapolis 14, Minnesota

DESIGNERS AND MANUFACTURERS OF WATERTUBE BOILERS, 2-3-4 DRUM AND PACKAGED DESIGNS, AUXILIARY EQUIPMENT, AND A FULL LINE OF INDUSTRIAL STOKERS.

REPORTS from the FIELD

Begins on page 154

Corp; Central Illinois Public Service Co; Central Louisiana Electric Co; Central Power & Light Co; Cincinnati Gas & Electric Co; Interstate Power Co; Kentucky Utilities Co; Middle West Service Co; Northern Indiana Public Service Co; Otter Tail Power Co; Public Service Co of Indiana, Inc; Public Service Co of Oklahoma; Southwestern Gas & Electric Co; and West Texas Utilities Co.

Texas Eastern signs to purchase large quantities of natural gas

► A CONTRACT BETWEEN Petroleous Mexicanos (Pemex) and Texas Eastern Transmission Corp has been signed providing for sale by Pemex of an initial quantity of 100 million cu ft of natural gas per day to Texas Eastern over a period of twenty years from date of first delivery, according to George T Naff, president of Texas Eastern.

Negotiations resulting in this contract have been taking place since March 1953. At the outset Pemex will receive from the contract an annual income of approximately five million dollars.

It is anticipated that original daily contract quantities will be 100 million cu ft per day, and Pemex is obligated, subject to certain conditions, to offer Texas Eastern up to another 100 million cu ft of gas per day as additional reserves are discovered by Pemex.

Home study course offered in industrial safety engineering

► INTERNATIONAL CORRESPONDENCE Schools, Scranton, Pa., now offers a home study course in industrial safety engineering. The course is designed to help industrial supervisors in charge of safety, industrial engineers who desire safety training, and those whose responsibilities call for a knowledge of safety practices in industry. Subjects covered include safety principles and practices, industrial psychology, mathematics, machine sketching, plant and production equipment layout.

Half-ton high-vacuum furnace shipped to Westinghouse

► CONSOLIDATED VACUUM CORP announces shipment of the first modular type 1000-lb capacity high-vacuum furnace to Westinghouse's Metallurgical Development Laboratory, Blairsville, Pa.

This is the first application of a new technique using modules or "building blocks" in designing and building high-

(*Continued on page* 208)

CONTINUITY IN ENGINEERING SERVICES

Stone & Webster Engineering Corporation designed and constructed the first unit of Somerset Station for Montaup Electric Company at Somerset, Massachusetts in 1924. Three years later the Engineering Corporation designed and built a second unit; in 1942 the first large high pressure controlled circulation boiler in this country and a third unit were installed; in 1947 a fourth unit was added and a fifth unit is now on the line.

Four-fifths of all the construction work of the Corporation amounting to well in excess of three billion dollars has been in the form of "repeat orders" from clients.

With the fifth unit shown above, Somerset Station has a net capability of 210,000 kilowatts

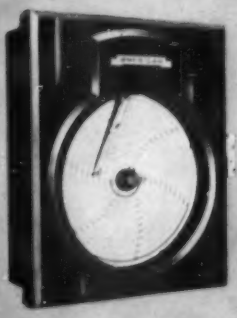
Write or call us for detailed information as to how our engineering, design, construction, report and appraisal services may be of assistance to you.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY *of* STONE & WEBSTER, INC.

New York Boston Chicago Pittsburgh Houston San Francisco Los Angeles Seattle Toronto

DIAL THERMOMETERS



RECORDING THERMOMETERS

GET SERVICE-PROVED ECONOMY

INDUSTRIAL GLASS THERMOMETERS

SPECIFY AMERICAN THERMOMETERS!

Is exact temperature measurement essential to safeguard your equipment? To assure uninterrupted service to customers? To maintain product quality? To control costs? Then American Thermometers belong in your plant! They are an unbeatable combination of highest quality materials, advanced design, rugged construction and precision manufacture. Their sustained accuracy protects processes, products and profits. Their long-life durability has been proved in outstanding performance in the severest services.

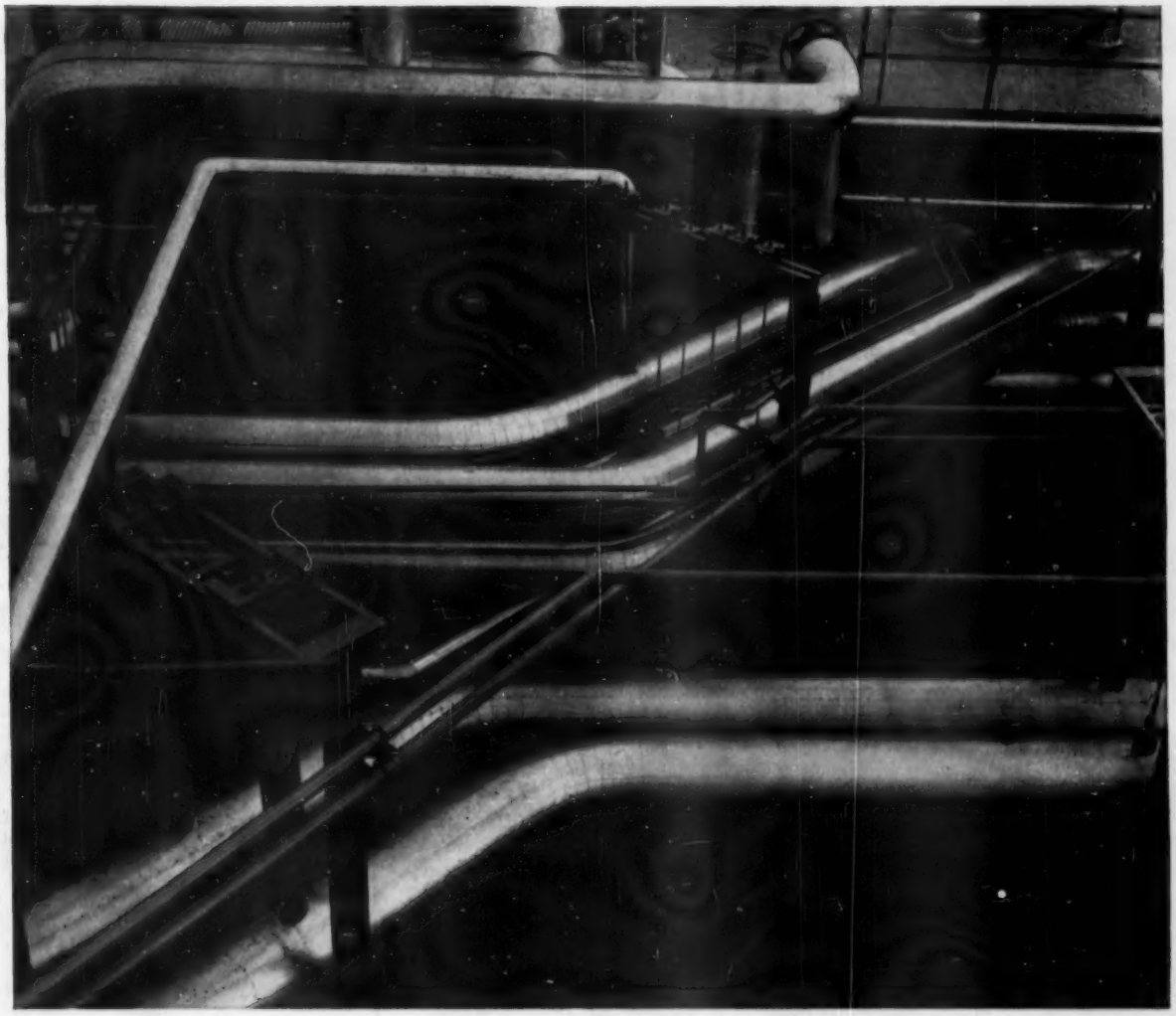
Whether you need industrial glass thermometers, dial types, or recorders, the complete American line provides for practically every application. Depending on instrument type and requirements, temperature ranges available are: minus 80° F. to plus 1150° F. Types of actuation include: mercury, vapor pressure, gas and bi-metal.

FOR EXPERIENCED COUNSEL, prompt delivery from local stocks, and greatest economy, buy through your Industrial Supply Distributor. Catalog sent on request.

AMERICAN INDUSTRIAL INSTRUMENTS

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'ASHCROFT' GAUGES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, *Stratford, Conn.* HANCOCK VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*



Unibestos lets steam pack more power

When high-pressure steam lines are protected with Unibestos, less heat escapes . . . more live steam is available for efficient power production.

Made of Amosite, Unibestos has strong, interlacing fibers that provide superior insulating protection with only *single-layer construction.* Easy to install, Unibestos is tough, durable insulation that withstands vibration . . . doesn't shatter even under extraordinary impact . . . inhibits corrosion. Built to last, it can be used over and over again without impairing its unmatched insulating properties. Unibestos® pipe insulation is available in sectional form through 44″ O.D.

Write for **Free** descriptive Bulletin 109C.

UNARCO

Joe Bestos says:

. . . Remember, single-layer Unibestos locks in more heat than most *double-layer* insulations!

UNION ASBESTOS & RUBBER COMPANY

1111 West Perry Street • Bloomington, Illinois

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Has the SOLUTION
for your
Water Conditioning Problems!

Laboratory ANALYSIS | Complete Plant Survey | "Check-Up" SERVICE

"Laboratory-fit" your plant's water supply to its specific uses, keep it operating at peak efficiency.

You're not just "buying chemical water treatment products when you avail yourself of the Deady SERVICE PLAN, offered without charge to our customers.

Under the Deady Plan, Deady Service Engineers, who *know every* type of water treatment equipment, are available to make complete plant surveys, help with preliminary layouts and make impartial recommendations that will assure maximum efficiency in water treatment.

A complete laboratory analysis of your water will enable us to prescribe the correct Deady Chemical Products, laboratory-fitted to your special water problems.

Regular periodic Deady Service Check-ups (plus laboratory analyses when indicated) provide *protective maintenance* to prevent costly damage to your water systems and boiler plants.

There's a Deady Product *right* for the water-conditioning problems of any industry using water to produce steam, for cooling or for any plant use. All Deady Products are formulated under strict laboratory control to suit individual plant conditions and raw water supplies.

A note or postcard will bring you full particulars regarding Deady Service and Deady Products. Write or call TODAY to...

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San Francisco, Calif.
Seattle, Wash.
Little Rock, Ark.
Memphis, Tenn.
Chattanooga, Tenn.
New Orleans, La.

REPORTS from the FIELD

Begins on page 154

vacuum furnaces. The same furnace can melt a 350-lb charge producing a single ingot, or a 1000-lb charge, operating on a semi-continuous basis. All alterations can be made in the field without disturbing the basic installation.

The vacuum-melting technique produces metals with physical characteristics impossible to obtain by other methods.

Calendar of Events

Dec 12-17—Engineers Joint Council, Nuclear Congress and Atomic Exposition to be held in Cleveland. Details from EJC, 29 W 39th St, New York 18, N. Y.

Jan 23-26—Plant Maintenance & Engineering Show. Convention Hall, Philadelphia. Details from Clapp & Poliak, Inc. 341 Madison Ave, New York 17, N. Y.

Jan 23-25—American Society of Heating and Air-Conditioning Engineers, Inc, Annual Meeting, Cincinnati, Ohio. Details from ASHAE, 62 Worth St, New York 13, N. Y.

Jan 30-Feb 3—American Institute of Electrical Engineers, Winter General Meeting. Hotel Statler, New York. Details from AIEE, 33 W 39th St, New York 18, N. Y.

Feb 1-2—Illinois Institute of Technology, held jointly with Chicago section of American Welding Society, 2nd Annual Midwest Welding Conference. Armour Research Foundation, Illinois Institute of Technology, Chicago. Details from IIT, 35 W 33rd St, Chicago 16, Ill.

Mar 12-16—National Association of Corrosion Engineers, 12th Annual Corrosion Conference. Hotel Statler, New York. Details from NACE, 1061 M & M Building, Houston 2, Texas.

Mar 15-16—Steel Founders' Society of America, Annual Meeting. Drake Hotel, Chicago. Details from SFSA, 920 Midland Building, Cleveland 15, Ohio.

Mar 18-21—American Society of Mechanical Engineers, Spring Meeting. Multnomah Hotel, Portland, Ore. Details from ASME, 29 W 39th St, New York 18, N. Y.

Mexican firm to get 16,000 kw combustion gas turbine-generators

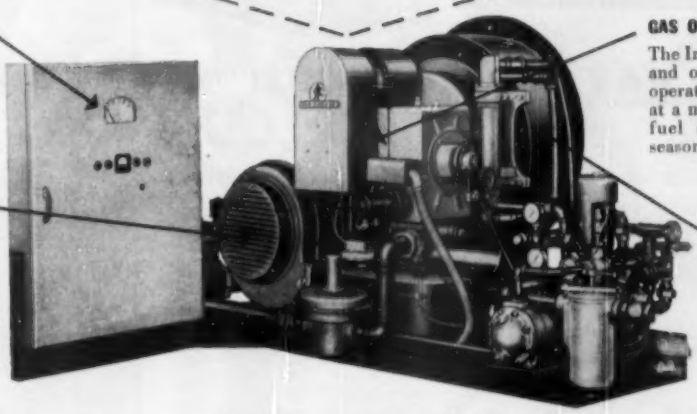
► PLANT ELECTRICA of Groupo Industrial in Monterrey, Mexico will install two General Electric 16,000 kw combustion gas turbine-generators in 1956. The sets will have a higher rating than any

Modernize your boiler room

with this dual-fuel firing unit

AUTOMATIC CONTROLS
All combustion controls are completely assembled, wired, and tested at the factory. They're fully enclosed in a single control panel for permanent protection from dust and damage.

FORCED DRAFT SYSTEM
This forced draft air supply makes possible automatic modulation over a wide range. It is sealed for positive pressure firing and eliminates need for a high stack. Direct-drive construction and low-speed ball-bearing motor assure long trouble-free life.



GAS OR OIL, OR BOTH
The Iron Fireman combination gas and oil burner allows switch in operation from one fuel to another at a moment's notice. Overcomes fuel shortage problems; gives seasonal price advantages.

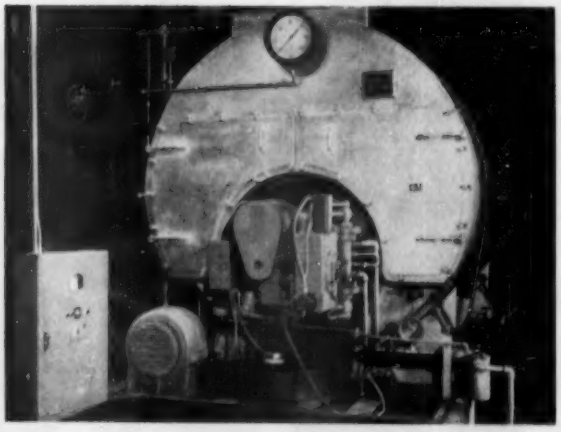
BUILT-IN REFRACTORY
The combustion throat, with built-in refractory, is an integral part of burner assembly. Eliminates on-the-job brickwork.

More than a burner— a complete *PACKAGE* firing system . . .

Iron Fireman package units are much more than conversion burners. They are *complete combustion systems*—with integrated burner (for gas or oil, or both), fuel control system, forced draft air supply, automatic controls, and pre-formed refractory combustion throat.

These firing units are adaptable to practically every type of boiler. Installation consists of little more than attachment to the boiler front, and making electrical and fuel connections. Consequently, installation time costs are sharply reduced from those of any comparable system, assembled in the field.

The Iron Fireman package plan factory-assembles all component parts. It eliminates the divided responsibility of assorted local contracts. And it brings long-range fuel and operating savings, which explain why more and more plants—like that of the Menasha Woodenware Corp. shown here—are switching to Iron Fireman package units



Menasha Woodenware Corp., Rockford, Ill., reports their Iron Fireman package unit has lowered fuel costs 6.6% during its first year, with steadier firing and greater cleanliness. Package units are available in a complete range of sizes, as well as the boiler-burner combination shown here. Installation by Allied Heating Engineers, Rockford, Illinois

It will pay you to get full information on Iron Fireman package burners and boiler-burner units. Just mail the coupon or write.

Send for full information . . .

IRON FIREMAN MANUFACTURING CO.
3047 W. 106th Street, Cleveland 11, Ohio
In Canada, 80 Ward Street, Toronto, Ontario.
Send information on Iron Fireman package burners.

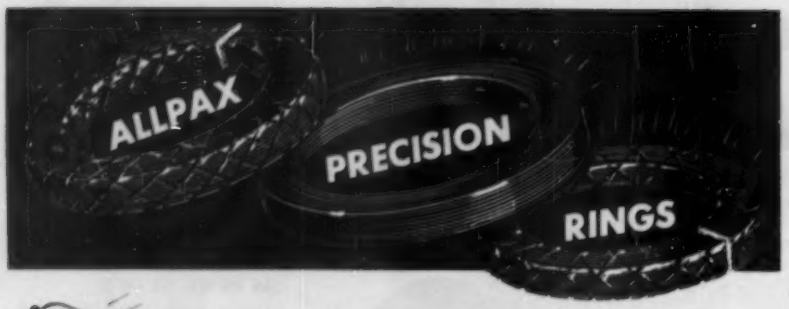
Name_____

Address_____

City_____ State_____

Iron Fireman®

AUTOMATIC FIRING EQUIPMENT FOR OIL, GAS, COAL
HEATING, PROCESSING, POWER



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ALLPAX Rings the Bell with the development of precision packing rings, designed for performance, and made of the finest materials available. Whether open-end or solid molded type, ALLPAX packing rings are precision made to your exact specifications. They increase efficiency because they give better service. Sample rings sent upon request.

SEND FOR OUR NEW CATALOG TODAY!
See our complete line of packings, tools, and gasket materials. Distributors in principal cities.

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160 Jefferson Ave. • Mamaroneck, N. Y.

These Special Frick Cooling Coils Are Making History by Cooling Synthetic Rubber Twice as Fast

One of 12 Test Chambers at Sperry Gyroscope, Great Neck, L. I.

Need a SPECIAL Cooling System?

Then the chances are that Frick engineering and production facilities can serve you.

We specialize in custom-built refrigerating and air conditioning equipment: our engineers, designers, foundrymen and mechanics team up to handle those unique jobs which other manufacturers hesitate to accept.

We just furnished, for example, a 25-foot shell, over 7 feet in diameter, with complete equipment for conditioning air at 100 pounds pressure for a huge wind tunnel.

Tell us what you need—we'll do the rest! Branches and Distributors in principal cities, the world over. Write

Orange Juice is Concentrated with Frick Reversed Refrigeration at 1/10th the Cost of Steam

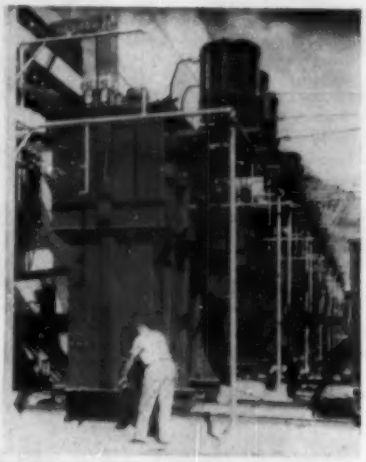
DEPENDABLE REFRIGERATION SINCE 1882
FRICK CO.
WAYNESBORO, PENNA. U.S.A.

REPORTS from the FIELD

Begins on page 154

yet manufactured in the Western Hemisphere, according to the General Electric Co announcement.

They are simple-cycle, single-shaft units, using natural gas as fuel. Eventually heat in the turbines' exhaust gas will generate process steam in heat recovery boilers. Generating both electric power and steam will make the installation highly efficient.



Water-cooled transformers used for aluminum pot lines

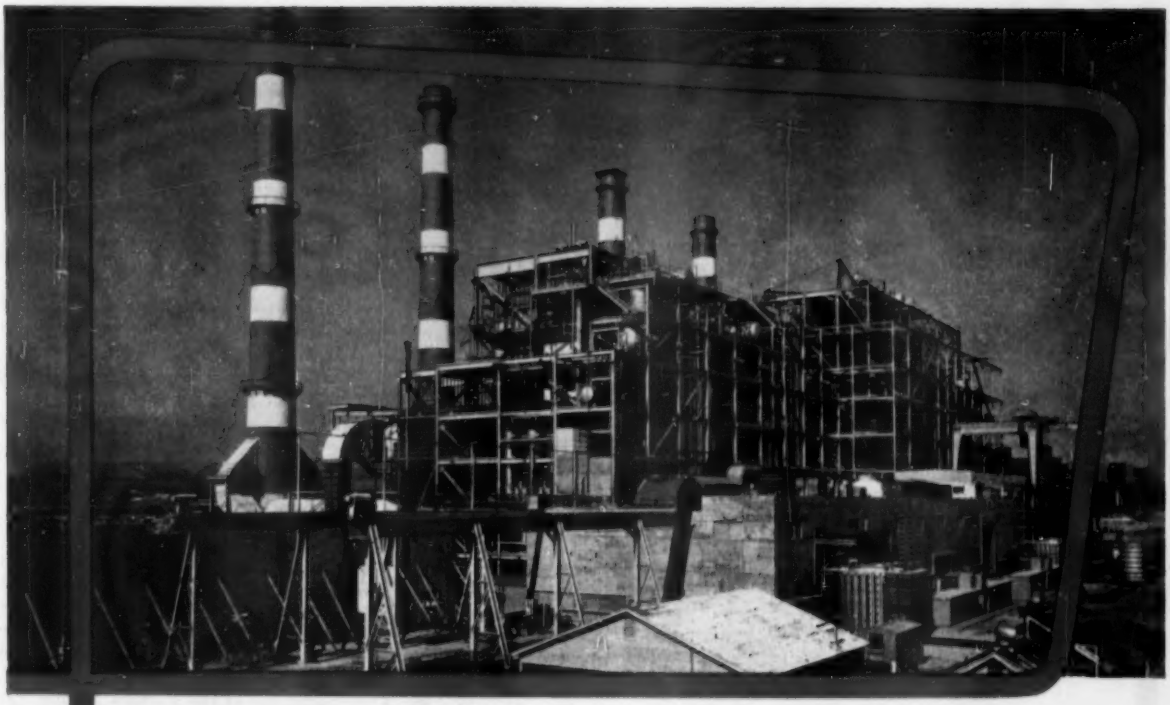
► WESTINGHOUSE TRANSFORMERS, *photo*, are first water-cooled rectifier transformers ever used on an aluminum pot line. They are serving Anaconda Aluminum Co's two new pot lines at Columbia Falls, Montana. Using the water-cooled units instead of the previous self-cooled ones is said to offer several operating advantages: (1) transformer floor area is reduced to less than half (2) weight is decreased by 35% (3) cost is less.

Sixteen rectifier transformers are used in this installation, eight for each of two 100,000 amp, 700-volt pot lines. Each 10,200-kva transformer takes power at 13.8 kv and feeds it into a 12,500-amp Westinghouse ignition rectifier unit at 700 volts. Eight rectifiers in parallel supply the 100,000-amp pot line.

Brooklyn Poly awards honorary degrees, climaxes Centennial

► THE POLYTECHNIC INSTITUTE of Brooklyn climaxed celebration of its Centennial anniversary by awarding 16 honorary degrees to industrial, scientific and community leaders at a convocation on Oct 8, 1955.

The Centennial celebration was marked under the theme "Science, Engineering, Research for Human Well-Being." Forty scientific, engineering



KEY-KAST® "Y" FITTINGS

to SERVE MAIN STEAM LINE in NEW LOS ANGELES POWER PLANT

Answering the need for extraordinary strength and endurance, KEY-KAST specially designed wyes have been installed in the main steam lines at the Valley Steam Plant Unit #4, City of Los Angeles, Department of Water and Power. The dependable performance of KEY-KAST wye fittings is achieved through careful engineering and special emphasis on:

1. Design backed by know-how.
2. Conforming to all requirements of The Code for Pressure Piping and The Power Boiler Code.
3. Complete quality control involving:
    1. 100% Radiography to A.S.T.M. Specification E-71, Class 2.
    2. 100% inspection by Magnetic Particle Examination both internally and externally.
    3. Every wye tested Hydrostatically.
4. Greater allowance against erosion—extra thickness at critical area.

SPECIAL NOTE: We invite your inquiries for main steam wyes, laterals, elbows, etc. In submitting your inquiries, please list design temperature pressure conditions, pipe or tube schedule or wall thickness and material.

Pipe fabrication in this modern West Coast power plant by Associated Piping & Engineering Co., Inc.

JOB DETAILS

FITTING:	14"x12"x12" 120° wye
MATERIAL:	2¼% chrome, 1% moly. Grade WC9
DESIGN CONDITIONS:	1925# @ 1000°F.

key company

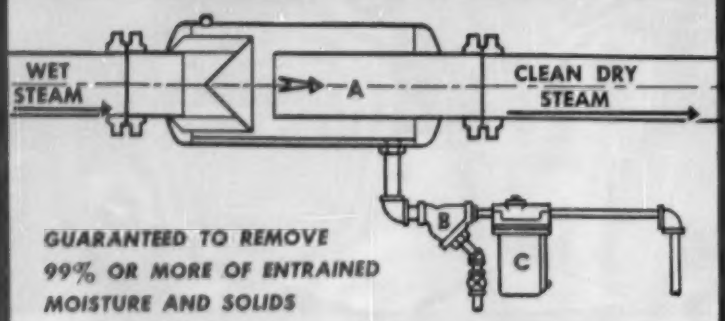
SINCE 1916... MANUFACTURERS AND DEVELOPERS OF PRODUCTS FOR HIGH TEMPERATURES AND PRESSURES

A DIVISION OF A.C.F. INDUSTRIES INCORPORATED

DISTRICT OFFICES: NEW YORK • CLEVELAND • CHICAGO • TULSA • HOUSTON • LOS ANGELES

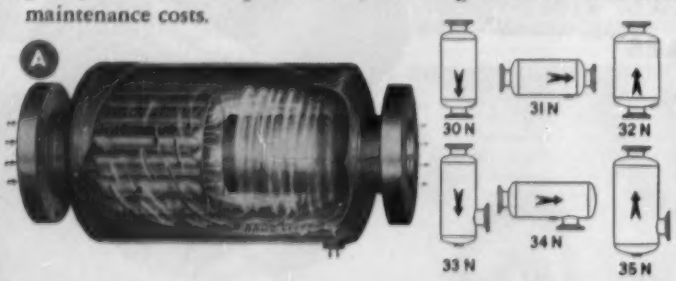
NOW—

The driest, cleanest steam available, is yours with this Wright-Austin equipment

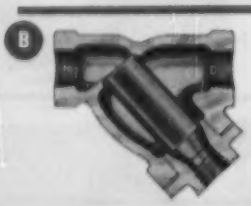


GUARANTEED TO REMOVE 99% OR MORE OF ENTRAINED MOISTURE AND SOLIDS

Live steam containing condensate, boiler compound, scale and other foreign matter is detrimental to equipment and is costly to super heat. These Wright-Austin accessories are engineered to give you maximum purification, resulting in lower fuel and maintenance costs.



This Wright Austin separator employs centrifugal force to remove impurities from steam, air or gas flow. The Type 31N, as well as other Models shown, are light weight, compact and sturdily constructed according to the ASME Code.



Foreign matter drains to Wright-Austin "Y" Type strainer which catches solids. These are periodically blown out by opening drain valve.

Condensate flows through strainer to Wright-Austin "Airxpel" Bucket trap. This unit automatically drains condensate as collected.

WRITE FOR NEW CIRCULAR 506-A

WRIGHT-AUSTIN COMPANY

3245 WIGHT STREET • DETROIT 7, MICH.

REPORTS from the FIELD

Begins on page 154

and educational conferences were held and attended by several thousand industrial and research leaders from here and abroad.

Among the honorary degree recipients were: Thomas E Murray, member, Atomic Energy Commission, holder of over 200 patients; Philip Sporn engineer and industrialist, president of American Gas and Electric Co; Lloyd V Berkner, geo-physicist and president of the Associated Universities Inc, Brookhaven; Erich Hausmann, engineer and Dean Emeritus of Polytechnic Institute where he was a staff member for 50 years.

Tests on metal roof decks help evaluate fire hazard

► WHEN THE UNDERSIDE of a roof is exposed to fire, burning gases from highly combustible materials in the vapor seal or adhesive between the insulation and the metal deck govern the spread of fire beneath the roof. This is one of the Factory Mutual Engineering Division's findings in a recent series of tests.

They used a specially designed structure. It duplicated conditions that would prevail during interior fire exposing the underside of steel deck roofs in industrial plants. The test program was conducted jointly with the Metal Roof Deck Technical Institute, and with the assistance of the Insulation Board Institute.

For a report of the test procedures and observations, send a check or purchase order for one dollar to Factory Mutual Engineering Div, 1151 Boston-Providence Turnpike, Norwood, Mass.

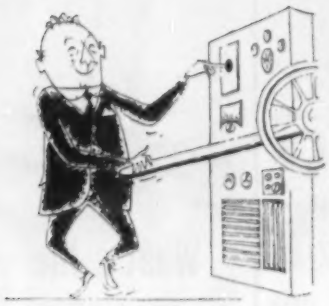
Oil "fingerprints" give inside information on engines

► OPERATORS OF TRUCK FLEETS can now get spot tests of the condition of the oil in their engines. A new test developed by Shell Oil Co, called the ADC Oilprint Analysis shows dispersancy, contamination and acidity of oil within a few minutes after it's removed from the engine crankcase.

To make the test, an analyst takes two drops of oil from the engine dipstick during or immediately following operation. The drops are released from a standard wire-rod on each of two circles printed on filter paper. After a minute or two the drops will have spread into identical patterns. One is read for contamination and dispersancy. The other is treated with a drop of specially formulized indicator and then read for alkalinity.

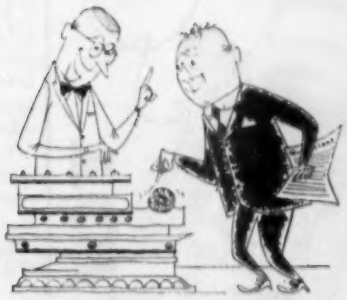
Water or anti-freeze contamination,

Push the button... pull the handle...



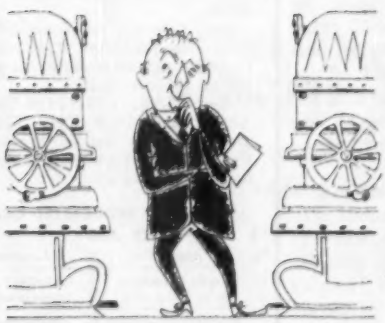
Try out . . . personally . . . the products you need to make your plant more efficient. More than 400 exhibitors of machines, services, supplies, materials and equipment for plant maintenance and engineering will show you new developments, new techniques.

Ask the question... get the answer...



No time delay . . . immediate technical answers to solve your specific, unique problems. Talk directly to the sales engineers and technical experts, in an atmosphere of their products . . . all in one place, at one time, under one roof.

See one... compare another...



Make your choice . . . right on the spot . . . you can see, touch, and try out competitive products side by side. The comparisons and decisions you can make in just four days will enable you to do a better job in your plant.

7th *National*

PLANT MAINTENANCE & ENGINEERING SHOW *& Conference*

January 23 to 26, 1956

Convention Hall, Philadelphia

Write for free tickets to the show and information about the Conference to:
Plant Maintenance & Engineering Show
Clapp & Poliak, Inc.
341 Madison Avenue, New York 17, N. Y.

Attend the Conference too!....

Hear the experts . . . top men in their fields . . . discuss topics of major interest to plant maintenance and engineering executives. There's no other way to get so much information for so little investment.

LIGHT • VERSATILE • TIMESAVING

Here's a new tool that's so chock full of uses it is difficult to list all of them. Though originally designed as a means of power to operate pipe threading tools, it is a highly desirable unit for many other uses. For example: Opening and closing large valves, winching operations, pulling wire through conduit, hoisting operations, operating augers, cranking operations. The PORT-A-PONY is a powerful portable power drive that will greatly reduce manual labor. Weighs only 26 pounds. Rugged construction, sturdy reversible ½ H.P. motor. Send today for new colorful bulletin on the "TOLEDO" No. 68 PORT-A-PONY with all applications illustrated. Remember — if it bears the familiar "TOLEDO" label, you know it's a dependable product. Manufactured by Thread-Ezy Mfg. Co., Subsidiary of The Toledo Pipe Threading Machine Company, 1445 Summit Street, Toledo 4, Ohio.

REPORTS from the FIELD

Continued from page 154

other contaminants like soot, dirt and debris that weaken the oil and dirty the engine will show up as a definite pattern. Dispersancy or lack of it will be obvious. Alkalinity or acidity show up as color halos on the treated spot.

Used in combination with coordinated field maintenance effort, the ADC oil print can help operators gauge periods between oil changes, thus prolonging engine life and saving money that might otherwise be spent for engine repair.

Items that have been spotted include clogged oil filters, restricted cooling systems, insufficient filter capacities, faulty thermostats, over-idling, worn out injectors, high-sulfur diesel fuels and other faults.

Present applications are for truck fleets only, although the future may see use for stationary industrial engines.

1955 "Accident Facts" now available

Both the number of industrial deaths and the industrial death rate were the lowest on record in 1954, according to the 1955 edition of National Safety Council's statistical booklet "Accident Facts." This yearbook contains facts and figures on all types of accidents—industrial, traffic, home, farm and school.

Twenty of the 96 pages are devoted exclusively to occupational accidents. Accident rates are listed by major industry groups, and charts show the accident trend during the last 25 years. Most common source of injuries, part of body most frequently injured, off-the-job accident problems, unsafe acts and unsafe conditions contributing to permanent impairments and deaths and other topics are included.

Anyone interested in preventing accidents or knowing the facts about accidents on a nation-wide scale will find this booklet invaluable. It presents many ideas and data for making speeches, writing articles, preparing reports and planning safety campaigns.

Price is $0.75 a copy, less for quantities. Address National Safety Council, 425 N. Michigan Ave, Chicago 11, Ill.

Portable gas turbine power plants to be built in Britain

► THE PORTABLE *Mars* gas turbine power plant designed and developed by Solar Aircraft Co of San Diego will now be produced in England. A new company, Sugg Solar Ltd, subsidiary of William Sugg and Co Ltd of Westminster, London will manufacture the gas turbine under license for both military and

Save money on gauge maintenance. Always keep two gauge glasses "on the bench" for every one in use.

You save time when replacements become necessary, because:

Spare No. 1 is right at hand for immediate replacement during routine cleaning and maintenance of the gauge.

Spare No. 2 is ready for sudden emergencies. Provides quick replacement in case of breakage at night, for example, when your Industrial Distributor may not be open.

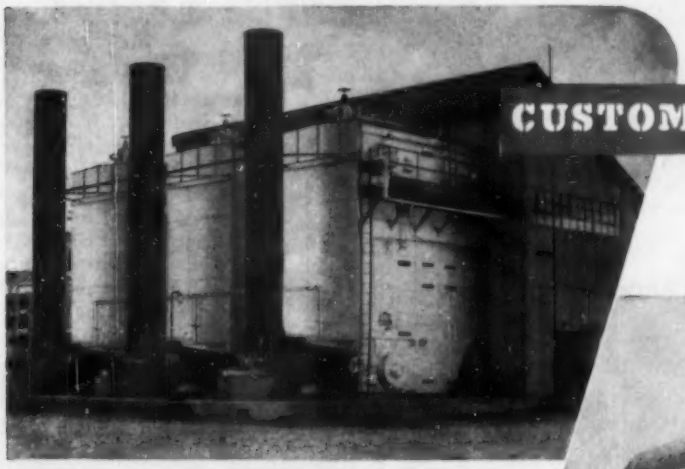
Play safe and smart on *all* your visual inspection problems. Call your Industrial Distributor, and order *extra* gauge glasses for all your vessels.

Remember: "ONE FOR THE GAUGE AND TWO FOR THE SHELF." And always specify hard-to-break CORNING®, PYREX® and MACBETH® gauge glasses. It's the economical way.

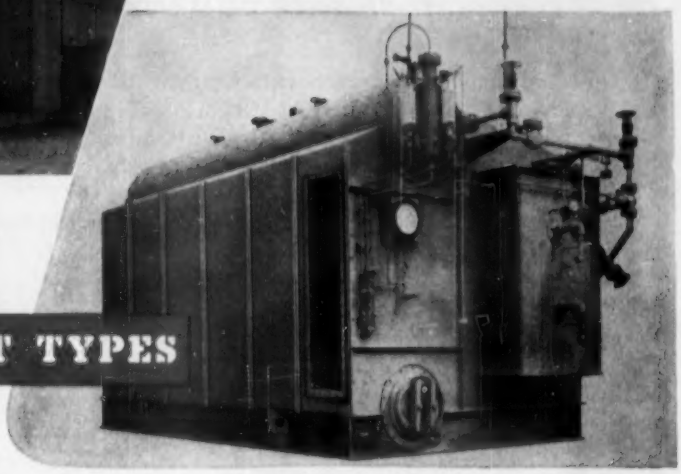
CORNING INDUSTRIAL GLASSWARE FOR EVERY JOB

Application	Recommended Product
Normal Conditions (Up to 100 p.s.i.)	CORNING brand standard gauge glasses
Higher temperatures	PYREX brand high-pressure gauge glasses
Higher pressures	PYREX brand heavy-wall gauge glasses
Extra visibility	PYREX brand red-line gauge glasses
Viewing inside furnaces, reactors pressure vessels, etc.	PYREX brand sight glasses
Lubrication inspection	PYREX brand lubricator glasses
Visible discharge devices	PYREX brand oil cup glasses

CORNING GLASS WORKS
Corning, New York
Corning means research in Glass



CUSTOM BUILT TYPES



PACKAGE UNIT TYPES

Stop 'n Shop at Vogt

for modern Steam Generators

Types and Sizes for Every Power, Processing and Heating Requirement

Steam costs too high? Then it's high time to replace outmoded boilers with modern Vogt steam generators of the type and size to exactly fit in with specific operating conditions.

Vogt steam generators are designed to give maximum rating in minimum space, with high efficiency and low maintenance expense. They are available in bent tube types and straight tube, forged steel sectional header types for solid, liquid or gaseous fuels burned singly or in combination.

Package units range from 10,000 to 30,000 pounds capacity and custom built units are obtainable in the larger capacities. Many installations in successful operation are proof of Vogt's ability to give effective help in the solution of steam generating problems. *Bulletins may be had upon request. Address Dept. 24-BP.*

HENRY VOGT MACHINE CO.

LOUISVILLE, KENTUCKY

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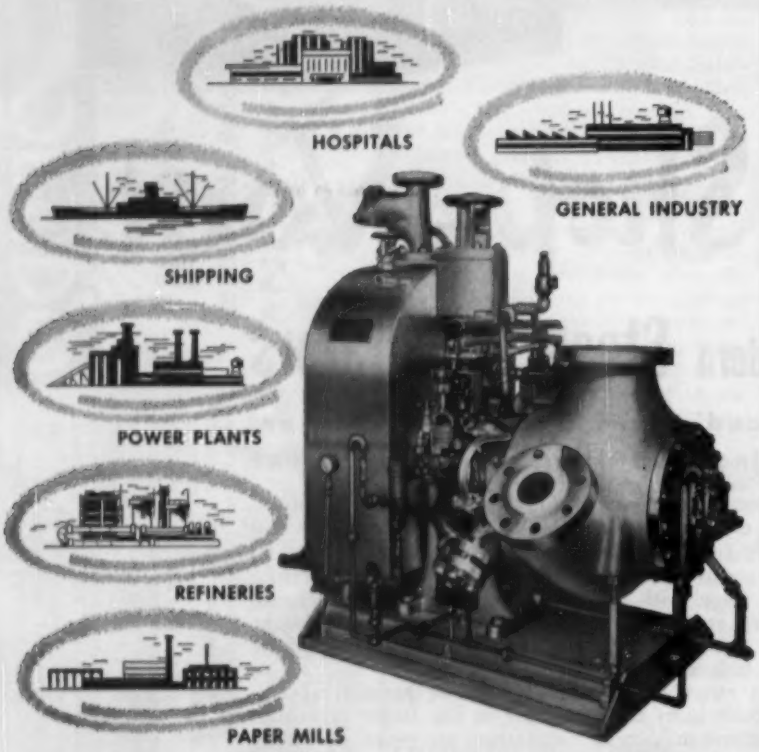
VERSATILITY!

ENGINEERED FOR OUTSTANDING PERFORMANCE IN MANY OPERATIONS!

On board ship, in refineries, hospitals, public utilities—in paper, textile and all general industry, the Coffin line of turbo equipment is earning nation-wide acceptance for outstanding performance. Designed with versatility in mind, latest addition to the line the Coffin "DE" Turbo Pump has a Volumetric Range to 800 GPM, Discharge Pressures to 1500 psi, Steam Temperatures to 850° F., Exhaust Pressures to 80 psig, and Liquid Temperatures to 325° F. Ratings can be exceeded in special installations.

Engineers! Write today for complete specifications. Ask for "DE" Bulletin G-110.



THE J. S. COFFIN, JR. COMPANY
326 South Dean Street Englewood, New Jersey
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Representatives in the United States, Canada, Europe, and the Far East

REPORTS from the FIELD

Begins on page 154

industrial uses at Crawley, Sussex.

The turbine develops 40 to 75 hp, depending on conditions. It operates at about 40,000 rpm on natural gas, or any distillate fuel like paraffin or petrol. The basic engine, including speed-reducing gears weighs less than 100 lbs and is smaller than a 2-foot cube.

It is already in service in the U. S. as a fire-fighting pump, an airborne generator set and a ground power unit for starting jet engines.

Five different heats needed to give pipe a 90 deg bend

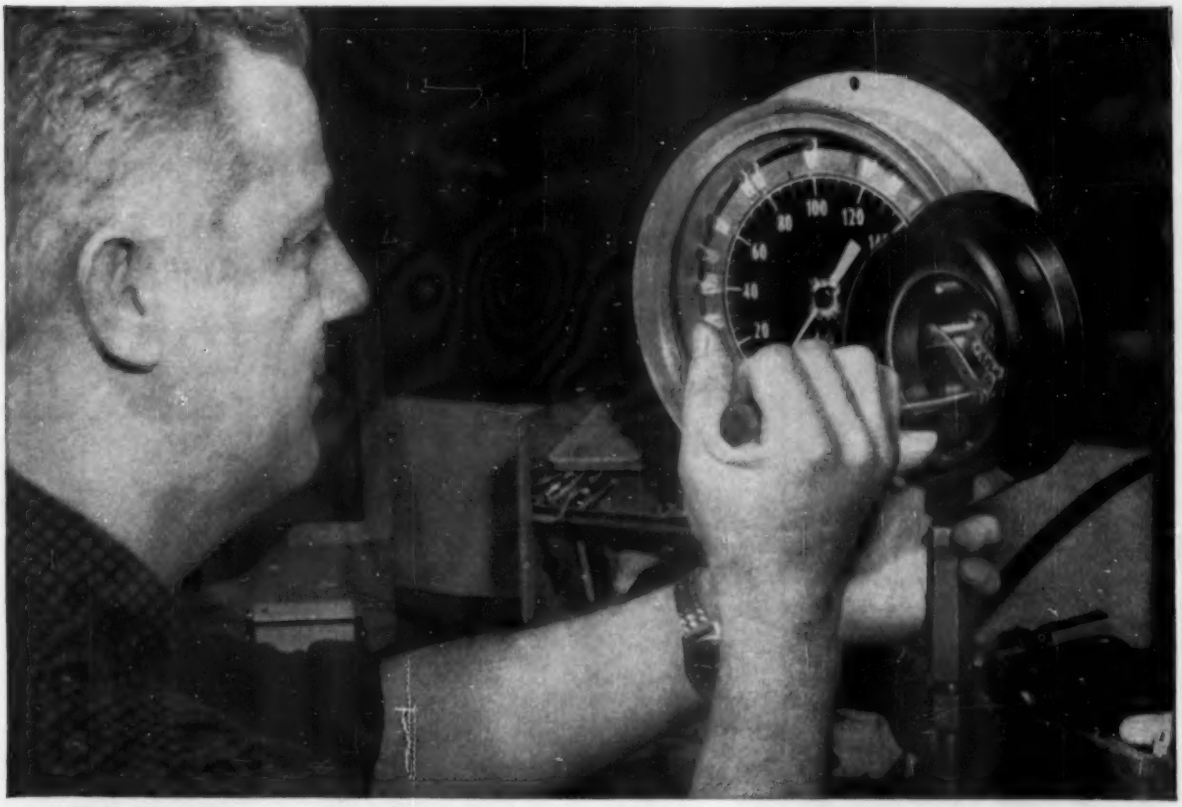
► FIVE DIFFERENT HEATS were required to give a 30-ft section of fusion welded chrome-moly pipe, *photo*, a 90 deg bend and an offset of 24 deg 18 min on an 11-ft radius. The extremely hard, high-temperature pipe has a 27½-in. OD with a 1½-in. wall thickness. It will be used at a generating station for 475-lb steam reheat at a temperature of 1050 F.

To insure against failure, Power Division of the Blaw-Knox Co, photomicrographs pipes like this as they arrive from the mill and after assembly has been completed. To compensate for natural thinning of outside walls during bends, this pipe was fabricated 10% thicker than specifications required, so that when bent, sufficient wall thickness would remain.

Ground has been broken for two new one-story buildings which will house extensive research and laboratory operations for the Crane Packing Co.

Plans for a 250,000-kw turbo generator, among the world's largest and most efficient electric-generating units, have been announced by Elmer L. Lindseth, president of The Cleveland Electric Illuminating Company.

Union Carbide Nuclear Company, a division of Union Carbide and Carbon Corp, has been formed to integrate the



Accurate gauge — accurate setting. Worker calibrates a pressure gauge equipped with a "K" Monel Bourdon tube at the Manning, Maxwell and Moore plant in Stratford, Conn. The company was the first to use long-lasting, corrosion-resisting "K" Monel for Bourdon tubes in a pressure range of 15 psi to 100,000 psi.

For high-pressure, high-temperature service

Gauges with "K" Monel Bourdon tubing ideally suited to meet today's needs

Can your gauges stand up to higher operating pressures, higher temperatures, and corrosion?

Ashcroft gauges made with Bourdon tubing of "K"® Monel can! Successfully used in a pressure range of 15 psi to 100,000 psi, they may be the answer to your problem.

Like all Inco Nickel Alloys, "K" Monel is strong . . . tough . . . corrosion-resisting. In addition, it has the low hysteresis and drift needed to assure gauge accuracy, and the good fatigue strength necessary for long-term service.

In short, "K" Monel helps bring to your gauging equipment hairline accuracy . . . trouble-free performance . . . and extended life. *Check for "K" Monel Bourdon tubing in the gauges you buy.*

And remember that "K" Monel — or one of the more than 50 other Inco Nickel Alloys — may provide the answer to some of your other equipment problems, too. Particularly if those problems involve high pressures, high temperatures, and corrosion. For any help you need in making a selection, don't hesitate to call upon Inco's Technical Service Section. They're always glad to work with power plant men on specific problems.

Meanwhile, Technical Bulletin T-9, containing valuable material on *Engineering Properties of "K" Monel,* may prove helpful. Write us for a copy.

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

More POWER for you . . . with "K" MONEL INCO TRADE MARK **NICKEL ALLOYS**

This Niagara Aero After Cooler also cools compressor jacket and intercooler water.

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- **Lower in Cost**
- **Drier and Cooler**

THE NIAGARA *AERO* AFTER COOLER offers a completely self-contained method replacing both shell-and-tube cooler and cooling tower. It is independent of a large supply of cooling water and consistently reduces compressed air temperatures to below ambient.

Drier air gives you better operation and lower costs in using all air-operated automatic instruments, tools and machines, paint spraying, sand blasting and moisture-free air cleaning.

Direct saving in the cost of cooling water saves the price of the Niagara *Aero* After Cooler in less than two years.

Niagara *Aero* After Cooler assures all these benefits because it cools compressed air or gas below the temperature of surrounding atmosphere; there can be no further condensation in your air lines. It condenses the moisture by passing the air through a coil on the surface of which water is evaporated, transferring the heat to the atmosphere. It is installed outdoors, protected from freezing in winter, proven in service on the largest plant utility systems.

Write for Bulletin No. 130

NIAGARA BLOWER COMPANY
Dept. P, 405 Lexington Ave.
NEW YORK 17, N. Y.
District Engineers in Principal Cities of U. S. and Canada

REPORTS from the FIELD

Begins on page 154

Corporation's diverse activities in the atomic energy field. Kenneth Rush, a vice-president of Union Carbide, has been appointed president of the new company.

A new battery of 75 coke ovens will be constructed at the Indiana Harbor Works of The Youngstown Sheet and Tube Co. The battery is expected to be in operation by September 1956.

Burns & Roe, Inc has created a new industrial division which will headquarter in Baltimore. Richard W Black has been appointed manager of the division which will offer industry engineering, design and construction service for new or expanding plants, facilities, equipment or processes.

Two of world's largest gas-turbine electric generators are being ordered for the city-owned power plant of Edmonton, Alta. Brown-Boveri will construct the units which will generate 20,000 kw at 68 F outside temperature.

Looking toward the potential world market for commercial nuclear reactors, North American Aviation, Inc has established Atomics International as a separate division to handle all of the company's nuclear engineering and manufacturing operations.

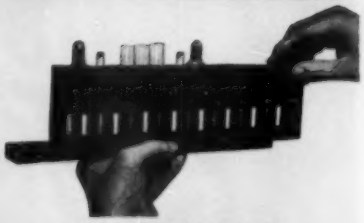
Two new additions totaling 90,800 sq ft are being added to The Trane Co's La Cross, Wis. plant 4 and another 30,000 sq ft is under construction at its Scranton, Pa. plant.

A contract in excess of $1-million has been awarded by North American Aviation to the Vinnell Co, Inc, of Los Angeles. The contract calls for construction of a nuclear research laboratory in the San Fernando Valley community of Canoga Park.

Firm named, Engineering Design and Development Company, 25 Broad St, New York 4, N. Y., has been established to do design, consulting and construction work on all types of chemical, metallurgical and industrial plants. Management is headed by P Sphaellos.

"You advertise for an experienced operator, Jackson?"

TEST
pH, PHOSPHATE
ON THE SPOT
with
TAYLOR COMPARATORS



GET ACCURATE BOILER WATER TESTS
In 3 Easy Steps!

For pH, place your sample right in the comparator tubes . . . add indicator to middle tube only . . . move the color standard slide across until colors match, and read result direct. That's all there is to it. Phosphate and nitrate determinations are just as easy.

Also, *Taylor Total Hardness Set* lets you determine hardness with ease and accuracy of an alkalinity titration.

COLOR STANDARDS GUARANTEED

Taylor liquid color standards carry an unlimited guarantee against fading . . . no danger of mechanical inaccuracy. Each complete set of standards is mounted in a lightweight, durable plastic slide . . . no single standards to handle.

SEE YOUR DEALER for Taylor sets or write direct for FREE HANDBOOK, "Modern pH & Chlorine Control." Gives theory and application of pH control, illustrates and describes full Taylor line.

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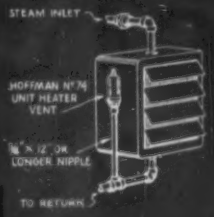
THE

BIG 3

HOFFMAN MAIN VENTS



No. 74

FOR STEAM UNIT HEATERS

Steam Unit Heaters must be "piping hot" to give best results. The smallest amount of air must be eliminated as fast as it accumulates. The No. 74 vent was designed to meet the unusual air problems in steam unit heaters. This vent will operate with rising, dropping or steady pressure.

Vents 300 Cu. In. of air per minute at 1 lb. and 800 C.I.M. at 10 lbs. Size Conn. ¼" male, ½" female. Max. Operating Press. 50 P.S.I.

No. 75 STEAM

The steam main must be hot first so that the heating system will get the maximum amount of heat in the miminum amount of time. The No. 75 vent with its large venting capacity lets the air out of the main permitting the heating units to function at their greatest efficiency.

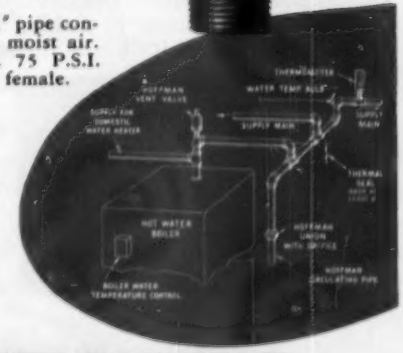
Size connection ¾" male, ½" female. Max. operating pressure 10 lbs.

No. 79 WATER VENT

For good circulation on any water system it is necessary to let the air out. The No. 79 with its special float mechanism and rugged construction vents the air from the mains on Hot Water Heating Systems—Domestic Water Systems—Summer-Winter Units—Industrial Processes.

Tapped at the top for ¼" pipe connection to conduct away moist air.

Max. Operating Press. 75 P.S.I. Size Conn. ¾" male, ½" female.



To get top performance on Steam Unit Heaters, Steam Heating Systems, Steam Process Work, Hot Water Heating Systems, Domestic Water, Summer-Winter Units—Water Process work, air must be eliminated from the mains. The "Hoffman Big 3 Main Vents" are designed to vent the air accumulations in the main so that the equipment will function effectively.

Installation of these main vents now on old or new jobs will insure the maximum efficiency of the equipment.

HOFFMAN VENTS

HOFFMAN SPECIALTY MFG. CORP.

VALVES, TRAPS, VACUUM AND CONDENSATION PUMPS, FORCED HOT WATER HEATING SYSTEMS

1700 West 10th St., Indianapolis 7, Ind.

Sold by leading Wholesalers of Heating and Plumbing Equipment

NOW OMNIGUARD...
Can Increase Production
...through low-cost insurance against down time

Whenever conditions call for prolonged, full capacity operation, critical temperatures can cause bearing failure – and result in ruinous shutdowns.

Increased temperature also shortens bearing life expectancy, before causing actual failure – another costly factor in the long run.

This is where the Edison Omniguard comes in – and where it pays its way many times over.

Omniguard's central monitor panel keeps *one* operator constantly posted on bearing temperatures in every plant unit . . . allows running at peak loads with safety.

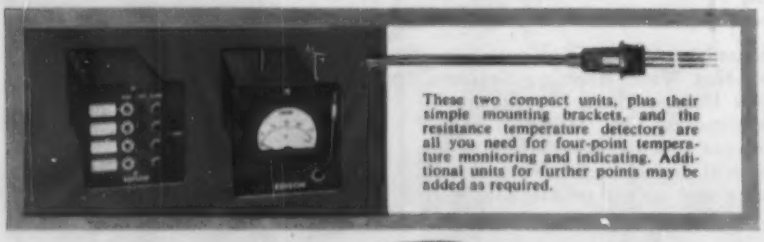
And full capacity operation can be maintained longer – because Omniguard sounds its warning before the damage level is reached.

You can trust Omniguard - because

- Entire system has no moving parts only simple *electrical* circuits, nothing to wear out.
- No adjustments or maintenance necessary – and installation costs are so low because only a minimum of wiring is required.
- Resistance Temperature Detectors are guaranteed accurate to ± 1% – drift less than ± .05%.

And Edison Omniguard costs so little . . . upwards of 50% less than any other monitoring system. This is truly the lowest cost insurance against down time—and Omniguard is so flexible – protects small or large plants with equal ease for an initial investment of less than $500.00.

Write today for article that shows how just a small increase in temperature can cut bearing life in half.



These two compact units, plus their simple mounting brackets, and the resistance temperature detectors are all you need for four-point temperature monitoring and indicating. Additional units for further points may be added as required.

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More FREE LITERATURE

Begins on page 169

9 **Fluorocarbon oils,** waxes and greases are discussed in 16-p bulletin. Contains data on chemical structure, specs, properties, applications. The M W Kellogg Co, Chemical Manufacturing Division, P.O. Box 469, Jersey City 3, N. J.

10 **Lubricating grease** that can be used at temperatures to 250 F is subject of single sheet bulletin 40. Includes time-temperature chart showing life of this grease at various operating temperatures. Sun Oil Co, Philadelphia 3, Pa.

MECHANICAL TRANSMISSION

11 **Roller bearings.** Forty-page bulletin gives construction, dimensions, capacities, housing and tolerance fits on company's staggered roller bearings, full- and cage-type needle bearings, journal roller bearings, cam followers, cam yoke rollers and thrust roller bearings. Orange Roller Bearing Co, Inc, 557 Main St, Orange, N. J.

12 **Electric brakes** and clutches. Illustrated 8-p application analysis report pictures and describes 21 of the numerous ways that company's standard units can be applied to power-transmission drives. Warner Electric Brake & Clutch Co, Beloit, Wis.

METALS AND ALLOYS

13 **Ductile iron,** revised edition, is title of 28-p bulletin containing tables, charts and photos. Up-to-date information and listings of typical applications are included. The International Nickel Co, Inc, 67 Wall St, New York 5, N. Y.

14 **"Measuring the crushing** resistance of rocks and ores" and "Measuring the relative abrasiveness of rocks, minerals and ores" are the titles of two articles by Dr B B Burbank that have been published in a booklet. Pennsylvania Crusher Division, West Chester, Pa.

15 **Hardness conversion chart** shows approximate relation between hardness by various testing systems and tensile strength of carbon and alloy steels. Hardness systems covered are Brinnell, Monotron, Vickers and Rockwell (B, C & E scales). The Babcock & Wilcox Co, Beaver Falls, Pa.

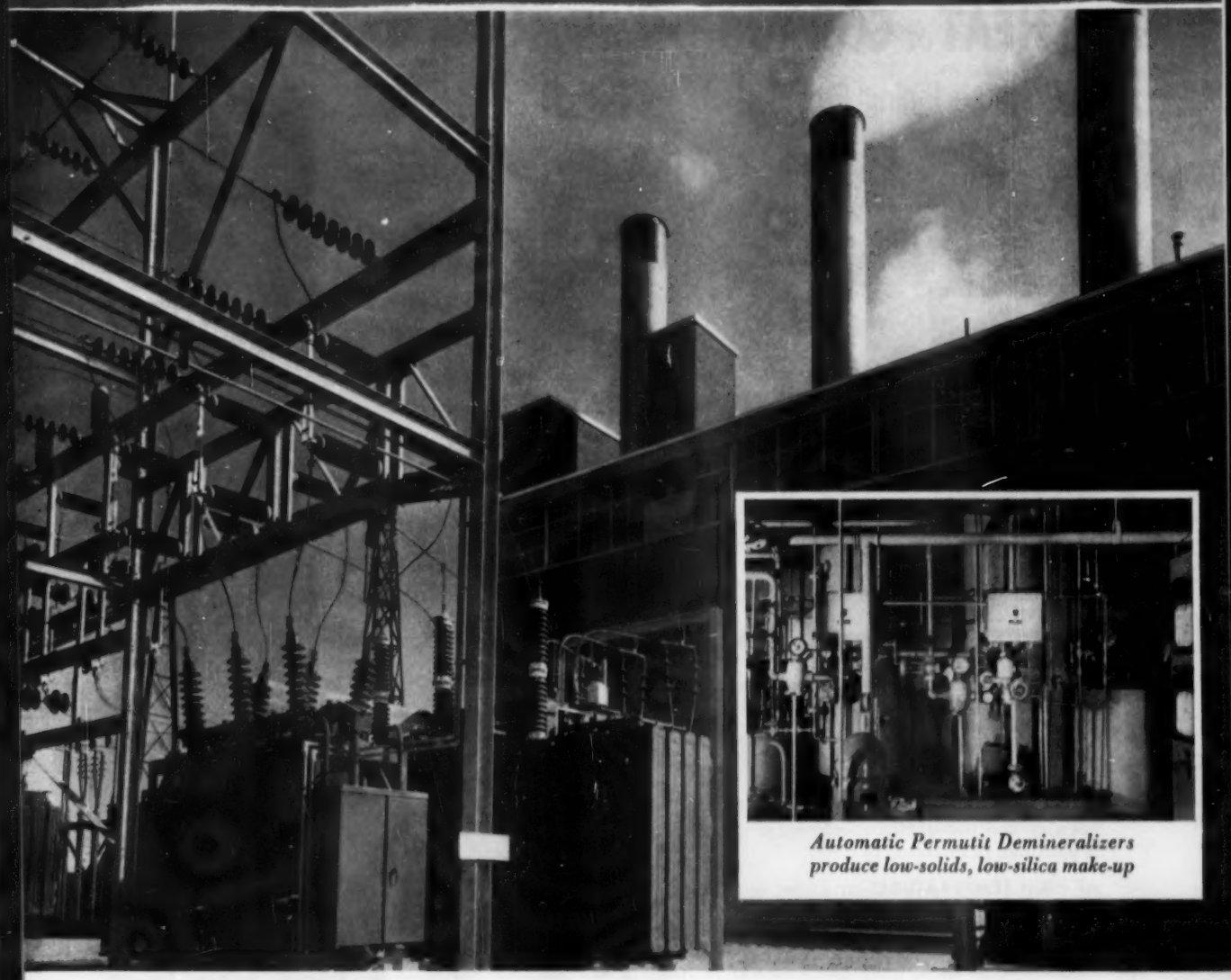
METERS AND INSTRUMENTS

16 **Pneumatic regulator** equipment. Illustrated 8-p bulletin H-3 contains info on filter-regulator combinations, filters and regulators, relays, purge assemblies and control panels. Conoflow Corp, 2100 Arch St, Philadelphia 3, Pa.

17 **Flow controller.** Four-page bulletin contains info on operation and installation, plus photos, flow diagrams and tables. Bulletin 600-J9A. Builders - Providence, Inc, 345 Harris Ave, Providence, R. I.

(Continued on page 222)

FOR IOWA SOUTHERN'S NEW $10,000,000 BRIDGEPORT STATION



Automatic Permutit Demineralizers produce low-solids, low-silica make-up

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Water by PERMUTIT®

Pioneer chose Permutit Demineralizers to protect Bridgeport's high-pressure boilers from raw Des Moines River water with its total hardness of up to 426 ppm, high silica of up to 11 ppm.

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Write for technical information. The Permutit Company, Dept. P-12, 330 West 42nd Street, New York 36, N. Y., or Permutit Company of Canada, Ltd., 5500 Royalmount Avenue, Montreal 9, Quebec.

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IN CORROSIVE SERVICE your pipe joints take a beating—fluid velocity and turbulence accelerate corrosion wherever there is a change in direction of flow.

AT HIGH TEMPERATURES structural changes in the metal can cause loss of strength and subsequent failure.

Those are good reasons for "playing it safe" in high pressure service with W-S Forged Stainless or Alloy Steel Pipe Fittings. W-S Stainless Fittings resist corrosion in a wide variety of process liquids and gases and high temperature steam. Available in Types 304, 316 and 304 L.

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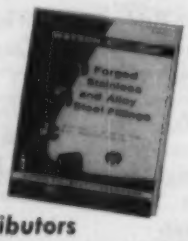

W-S Forged Stainless and Alloy Steel Fittings can be obtained in Screw-End Type for 2,000 lb., 3,000 lb., and 6,000 lb. WOG service; Socket-Welding Type for Schedules 40, 80, 160 and Double-Extra Heavy Pipe. Send today for bulletin S-1-55.

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H. K. PORTER COMPANY, INC.

Roselle, N. J.

More FREE LITERATURE

Begins on page 169

18 **Gages** for draft, pressure, differential gas pressure and temperature are described in 12-p bulletin 806. Individual self - contained units may be mounted separately or grouped together. Republic Flow Meters Co, 2240 Diversey Pkwy, Chicago 47, Ill.

19 **Thermocouples** for liquid, gas and surface - temperature measurements are discussed in four bulletins, 1601, 2, 3 and 4, totaling 14 pages. Bulletins contain outline drawings of standard units, info on conductors, junctions, tubes. Revere Corporation of America, Wallingford, Conn.

VALVES, FITTINGS, SPECIALTIES

20 **Drop-forge steel valves,** gate, globe and angle types, sizes ¼ through 2 in., are described in supplement 1 to catalog F-9. Henry Vogt Machine Co, P.O. Box 1918, Louisville 1, Ky.

21 **Butterfly valves.** Product and installation photos, design info, components, type operators, accessories compose 4-p bulletin 650-L1B. Builders - Providence, Inc, 345 Harris Ave, Providence, R. I.

22 **Hydraulic tube fittings.** Twenty-page bulletin 4301 provides full dimensional info on straight-thread fittings with O-ring sealing. Tube & Hose Fittings Division, Parker Appliance Co, 17325 Euclid Ave, Cleveland 12, Ohio.

23 **Hose couplings.** Featured in this 20-p bulletin are full-page cutaway views that show design and construction details. Also described are single and double check valve modifications of the coupling that seal off one or both ends of a fluid line when unit is disconnected. Titeflex, Inc, 10 Hendee St, Springfield 4, Mass.

24 **Ball joints** for use in piping for power, process, heating, chemical, construction or hydraulic service are described in 20-p bulletin 215-B. Units are available for working pressures to 4500 psi and temperatures to 1000 F. Barco Manufacturing Co, Dept 48, 501 N Hough St, Barrington, Ill.

25 **Pressure hose** and reusable couplings for use in making up hose assemblies for hydraulic and other heavy-duty applications are discussed in 12-p bulletin 3040-A. The Imperial Brass Manufacturing Co, 1200 W Harrison St, Chicago 7, Ill.

PUMPS

26 **Motor-driven pumps** for low capacity flow control are detailed in 4-p bulletin 955. Contains diagrams, photos, application info and full specs. Milton Roy Co, Station O, 1300 E Mermaid Lane, Philadelphia 18, Pa.

(*Continued on page* 224)

Evenly matched or not...

there's enough difference to make all the difference

Before the bout, two fighters may look equally good to the fans. After a round or two, the differences begin to show up.

It's the same with heat exchanger tubes. They all start out looking pretty much alike, but under the test of day-in, day-out operation, Scovill Phosphorized Admiralty Heat Exchanger Tubes have consistently shown superior performance.

Hot-extrusion from Scovill Continuous-Cast billets means uniformity in the metal, uniformity of chemical composition and grain structure, uniformly high phosphorus content. It means sounder metal—smooth, dense, free from pits or porosity. These—plus Scovill's unrivaled Technical Application Services—are, indeed, differences that make *all* the difference in economical, uninterrupted service under tough operating conditions. Let us tell you more about them.

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More FREE LITERATURE

Begins on page 169

27 **Universal pumps**—a type of centrifugal pump made especially for large circulated water systems where smooth and silent operation is required—are detailed in 4-p bulletin HC-855. Bell & Gossett Co, Morton Grove, Ill.

WATER TREATMENT

28 **Chlorinizers.** Illustrated 4-p bulletin 840-K16 with typical installation and control arrangement diagrams, is divided into two sections—semi-automatic control and step control. Builders-Providence, Inc, 345 Harris Ave, Providence, R. I.

29 **Control panels** and cubicles for modern water-conditioning plants are described in 8-p bulletin 4178. Contains photos, typical assemblies. The Permutit Co, 330 W 42nd St, New York 36, N. Y.

30 **"Better water"** is title of 14-p bulletin that outlines facilities and services of the company and shows typical installations and equipment. General Filter Co, 923 2nd St, Ames, Iowa.

31 **Sluice gate** with flush bottom closure is described in 12-p bulletin 75. Contains photos, construction details, installation and operation data. Unit is used for water - filtration plants, power plants, municipal and industrial-waste plants and for flood control. Rodney Hunt Machine Co, Orange, Mass.

ATOMIC ENERGY

32 **Nuclear research reactors.** Illustrated 8-p bulletin GEA-6326A describes company's swimming-pool reactor, water - boiler reactor, heavy-water research reactor and nuclear test reactor—lists application recommendations for all four. General Electric Co, Apparatus Sales Division, Schenectady 5, N. Y.

33 **Nuclear test reactor.** New 20-p bulletin details operation of company's light-water and oil-moderated reactor, using heterogeneous —enriched fuel. General Electric Co, Apparatus Sales Division, Schenectady 5, N. Y.

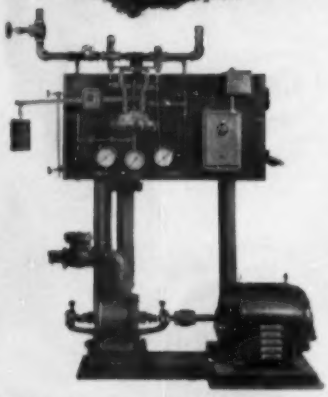
34 **"The atom in our hands"** is title of 44-p bulletin that describes some of the work being done at the atomic energy center at Oak Ridge, Tenn. Includes info on how radioisotopes are produced, photos of several reactors. Union Carbide and Carbon Corporation, 30 E 42nd St, New York 17, N. Y.

MISCELLANEOUS

35 **Heat exchangers** for recovery of heat from high-temperature waste gases are described in 8-p bulletin. Unit is designed to withstand gases at pressures to 100 psi and temperatures to 2100 F. The Griscom-Russell Co, Massillon, Ohio.

Cut Steam Costs

with Stickle's differential drainage and boiler return system



A closed pumping system for returning condensation from heating and processing equipment under pressure directly to boiler at temperatures only 15 to 20 degrees lower than those at operating pressure. For plants using steam pressures between 50 and 250 lbs. Cuts the cost of steam these eight ways:

1. Cuts fuel costs 10% to 25% by completely salvaging condensate and returning to boiler at 300 degrees or higher.
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3. Reduces use of raw make-up water 85% to 90%.
4. Cuts maintenance on boilers, steam lines, traps and valves.
5. Improves quality by permitting operation of processing units at peak efficiency.
6. Cuts power used for pumping up to 75%, since system requires only 25 lbs.
7. Automatically maintains positive circulation without steam loss.
8. Eliminates flash steam waste.

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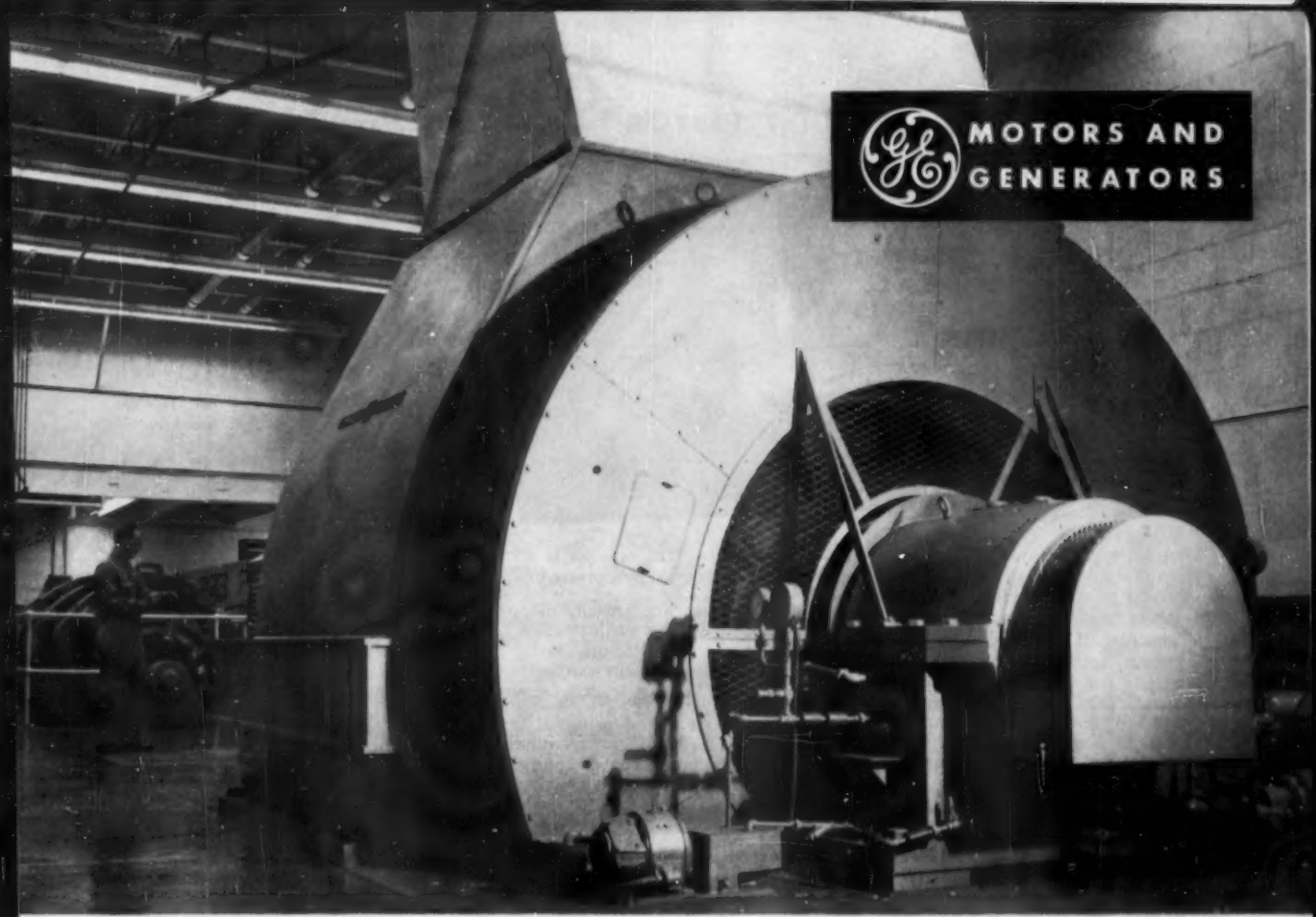
Regulating and Reducing Valves
Drainage and Boiler Return Systems



GENERATOR WITH BASE RATING OF 60,000-KVA HELPS CREATE OPERATING CONDITIONS FOR LARGE MOTOR RESEARCH IN NEW G-E LAB.

In New G-E Development Laboratory Giant Motors Perform Just as in Service

One of the difficult problems design engineers face is predicting accurately how a giant motor will perform under operating conditions. General Electric has come up with an answer to this problem.

INCREDIBLY ACCURATE TEST CONDITIONS are made possible by the brand new G-E test laboratory pictured above. Heart of the test room is a synchronous generator with a base rating of 60,000-kva driven by a variable speed d-c motor to provide test current of variable frequency. A motor-generator set to supply the d-c current, exciter sets and elaborate switchgear make it possible to simulate test conditions far more severe than are encountered in the field.

DATA GAINED FROM TESTING today's motors and generators will be directly applied to the design and development of tomorrow's machines. Product development like this is an integral part of General Electric's continuing program to provide you with dependable, compact, efficient electric equipment.

Take advantage of this progressive engineering research and bring your large motor and generator problems to General Electric. For more information on G-E motors and generators call the nearest General Electric Apparatus Sales Office. General Electric Company, Schenectady 5, N. Y. 770-41

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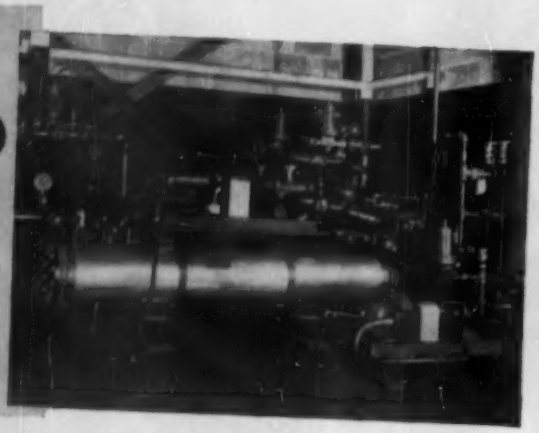
2 ENCO FUEL OIL UNITS *in this plant*



Here is a typical 2 unit installation of Enco fuel oil pump sets—selected to take care of all the requirements of a building materials manufacturer.

The Large Unit has 2 pumps and 2 heaters, completely automatic and arranged for operation with either heater, or either pump—or both. With one heater and pump the capacity is 11 gpm Bunker C oil at 300 psig pressure, and temperature rise from 90F to 230F.

The Small Unit is for cold starting up—has no heater. The capacity is 3 gpm of No. 2 oil at 300 psig pressure.

All Enco sets are individually designed, each for specific plant conditions—for easy installation, low maintenance and minimum carefree operation.

Complete details including the 10 important features of Enco fuel oil heating and pumping sets are given in Bulletin OB53. Copies gladly sent upon request.

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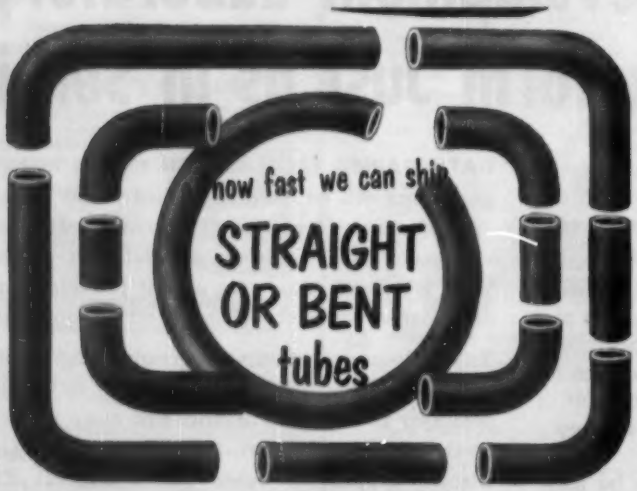

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More TECHNICAL BRIEFS

Begins on page 156

breaker include as one of its primary requirements that of functional and mechanical simplicity. Consideration such as these were an important factor in the design and development of the new 500 MVA air magnetic circuit breaker described in this paper. *AIEE paper No. 55-509.*

Surge protection on industrial systems. *By C L Wagner, Westinghouse Electric Corporation.*

The rapid expansion of industrial-plant distribution systems in recent years has caused many new problems for the plant design engineer. It has also accentuated certain problems that in the past caused little concern. Surge protection for the plant system is one of these latter problems.

In the past, the philosophy behind surge protection was primarily to prevent damage to the electrical equipment itself and thereby keep the repair costs for this equipment to a minimum. With this philosophy, not too much emphasis was placed on surge protection by the overall plant designers. In recent years, however, continuity of service has become a paramount concern. Now the breakdown of a piece of equipment means not only repair or replacement expense, but more importantly, loss of production for that portion of the plant effected by the breakdown. In many cases, primarily in the chemical industry, it could mean the complete shutdown of the plant due to the interruption of a critical processing operation. Small wonder that more and more emphasis is being placed on surge protection by the plant designers.

Adequate surge protection consists not only of protection against lighting surges but also against transient voltages due to switching surges or arcing ground faults. In many cases, damage due to these transient voltages is far more extensive than that caused by lightning surges. Proper system design, therefore, requires that protection be afforded against both types of surges.

The science of surge protection is one of "prevention plus control." The first step to be taken by the plant designer is to attempt to prevent the occurrence of surges on his system. This might take the form of shielding of his lines and stations to minimize the probabilities of lightning strokes to his system. It might also take the form of proper grounding to prevent the establishment of excessive transient voltages. The second step is to provide a means of controlling the surges that slipped by

Directions for ordering papers on p 238

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More TECHNICAL BRIEFS

Begins on page 156

the preventive schemes. This may take the form of lightning arresters, surge capacitors or any other equipment necessary to prevent damage to the apparatus on the system. Both steps must be taken to provide the maximum in protection for the plant system. The paper presents some of the prevention and control methods available for the protection of plant electrical equipment against switching as well as lightning surges. *AIEE paper No. 55-690.*

Direct-current high-potential testing of large generators. *By H H Lang and W D Houser, Westinghouse Electric Corp, Hamilton, Ont, Canada.*

In view of the high degree of interest shown recently in developing a standard for direct current for high voltage testing of generator windings, it has been felt that the results of twelve years' experience with direct current in Canadian Westinghouse Company might make an interesting and useful contribution to the available information on the subject. The conditions leading to the adoption of direct current for high potential testing and a summary of the machines so tested during that period, with a report on the conclusions reached, are given in this paper. *AIEE paper No. CP 55-504.*

Heat-resistant insulation systems for motors. *By C J Herman and K N Mathes, General Electric Company.*

The thermal stability of a new magnet wire known as Alkanex wire has been evaluated as a component of heat-resistant motor insulation by four different test methods. Alkanex wire has been shown to possess approximately a 40-C superiority in thermal stability as compared to Formex wire when used with suitable varnish systems. It is important to choose varnish and solvent systems which are compatible with the wire enamel. It is concluded by test that Alkanex wire can be used in equipment operating at Class B temperature and that use need not await confirmation by long service trials. *AIEE paper No. 55-495.*

Operating experience with a mechanical rectifier. *By J Chamulak and J W Tracht, Pennsylvania Salt Mfg Company, and W C McCullough, I-T-E Circuit Breaker Company.*

The first 10,000-ampere 60-cps mechanical rectifier installed in the United States has now completed 32 months of operation. Anticipated high conversion efficiency has been confirmed. The cur-

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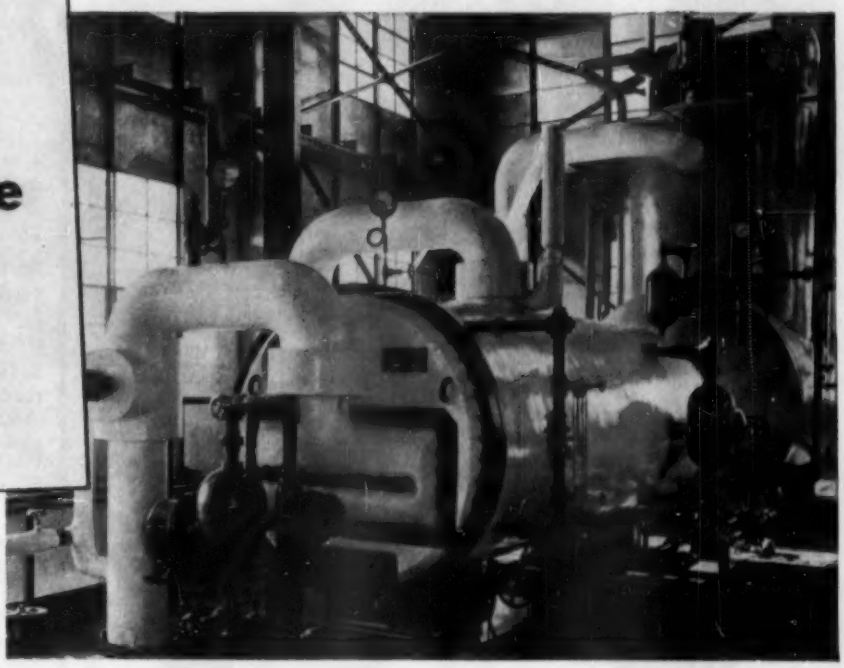
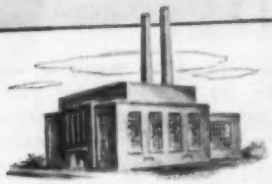
Important!

if you have a moderate size boiler plant





Evaporators for eliminating the impurities from boiler feed make-up were originally developed for large power generating stations.

However, the results obtained with G-R Type R Horizontal and Type H Vertical Bentube Evaporators in industrial plants all over the country have proved that *moderate size plants* can also frequently profit by the many benefits of distilling the raw water supply.

This is a possibility well worth your investigation. Boiler feed purification by G-R Evaporators does not involve the use of chemicals nor require periodical water tests or manipulation by skilled operators. Moreover, it is the simplest method of eliminating raw water impurities.

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G-R Type R and Type H Evaporators are adaptations of the larger Type J-2 Bentube Evaporator—widely used by central power generating stations. They embody the exclusive scale-shedding G-R Bentube heating elements, and have many additional distinctive G-R features that assure ample capacity, pure dry vapor, long service, low maintenance expense and convenient attendance.

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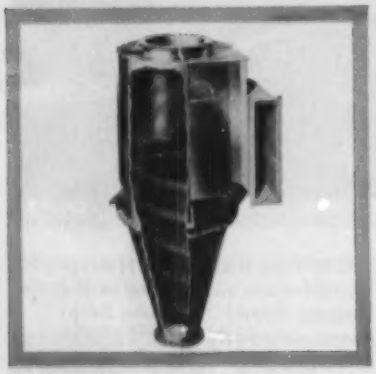
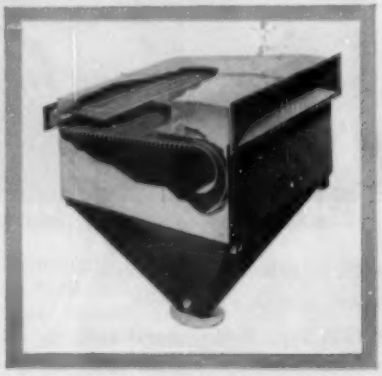


Buell Cyclone Collectors are noted for their efficiency, too. Here are exclusive reasons why: shave-off design which harnesses back-flow and puts it to work . . . plus extra large diameter design to prevent "plugging."



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More TECHNICAL BRIEFS

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rent supplied the isolated electrolytic load has been controlled well within the required limits. Contact life remains the major maintenance problem. However, recent developments in contact design have increased contact life and give promise of still further increase. This rectifier, manufactured by the I-T-E Circuit Breaker Co., was placed in service at the Wyandotte, Michigan plant of the Pennsylvania Salt Manufacturing Company in May, 1951. *AIEE paper No. 55-555.*

Fault location with radar equipment. *By H L Garton, Commonwealth Edison Co. APC paper; no number.*

A modern voltage regulator—its function and application. *By H W Gayek, A S Rubenstein, M Temoshok, General Electric Co. APC paper; no number.*

Dry-type versus liquid-filled transformers for industrial applications. *By W M Terry, Jr, Allis-Chalmers Manufacturing Co. APC paper; no number.*

Series capacitors eliminate voltage fluctuations in industrial plants. *By T H McGreer, Sargent & Lundy. APC paper; no number.*

Fluid flow

An extension of the theory of water hammer. *By R Skalak, Asst Prof of Civil Engineering, Columbia University.*

The usual theory of water hammer that is used to compute magnitude and velocity of pressure waves in a pipe filled with an elastic fluid was given by Joukowsky in 1898. This theory predicts that pressure waves travel without change of shape. In the present paper, water-hammer waves are considered without some of the simplifications made in the Joukowsky theory. Equations of motion for a thin cylindrical tube are used. Only the case where velocity of sound in the material of the pipe wall is greater than in the fluid is considered. Much of the analysis would be valid in the opposite case, but relative speeds of the various waves would differ. *ASME paper No. 55-S-18*

Survey of mass-rate flow-measuring principles. *By Y T Li and S Y Lee, Massachusetts Institute of Technology.*

Devices to measure mass flow or weight flow have aroused great interest during the past few years. This interest stems from need in industrial process control and military fields for more accurate and faster ways of me-

Directions for ordering papers on p 238

NEW SUPER RAYNILE CONVEYOR BELT 400% STRONGER

Provides the economical answer to transporting coal and other bulk materials over long distances and up steep slopes.

This remarkable new Hewitt-Robins conveyor belt reinforced with the revolutionary synthetic fabric, Super Raynile, makes possible an entirely new concept in single-section conveyor application. It solves difficult materials handling problems where topography and other conditions require the use of a long single-length conveyor.

Already in service, Super Raynile has the highest operating tension of any conventional carcass belt. Because of its tremendous tensile strength, 400% greater than conventional cotton reinforced belts, a single conveyor section *5¾ miles long* can be built over level terrain to carry material at 400 TPH using only a 6-ply Super Raynile belt 30 inches wide. This same belt can also lift material from ground level to a height of 830 feet.

The new Hewitt-Robins Super Raynile conveyor belt is highly flexible and pliable despite its great strength. Its cost is less than steel-reinforced belts and Super Raynile can easily be spliced in the field more quickly, more economically and without the specialized equipment required to splice steel-reinforced belts.

Super Raynile belt is available in a wide range of specifications . . . widths up to 72" — thickness up to 15 plies.

Learn more about this new long-length, long-life conveyor belt. Contact your local Hewitt-Robins Industrial Supply Distributor (see Classified Phone Book), or write direct to "Super Raynile Belt", Hewitt-Robins Incorporated, Stamford, Connecticut.

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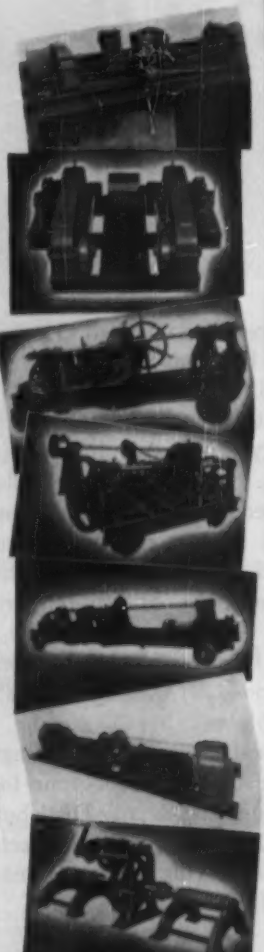

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More TECHNICAL BRIEFS

Begins on page 156

tering fluid than is possible with conventional, inferential-type flowmeters. Generally speaking, mass-flow or weight-flow information is more useful and desirable than the volumetric flow rate. However, because of their simpler construction, conventional inferential-type meters, such as area or heat meters, have been extensively used.

To obtain mass-rate-flow information from these meters, reading must be corrected for related fluid properties such as density and viscosity as well as environmental conditions such as temperature and pressure. With present highly-developed computational techniques, it is possible, theoretically, to correct these quantities automatically. And any inferential-type meter can be made to measure mass-rate flow by correcting with suitable transducers the effects of density, viscosity, pressure, velocity, etc.

Unfortunately, since these quantities are often interrelated in a rather complicated fashion, a high degree of accuracy over a wide flow range cannot be easily obtained. The situation is complicated further when the fluid is nonhomogeneous. A true mass-rate flowmeter, on the other hand, is one that can produce a signal that corresponds to the mass-rate flow directly and is substantially independent of various fluid properties and environmental conditions. The paper discusses true mass-rate meters as well as some conventional inferential meters with density correction. *ASME paper No. 55-SA-72.*

Hydro

Mechanical alignment of vertical-shaft hydroelectric units as practiced by Tennessee Valley Authority. *By C L Norris, Tennessee Valley Authority.*

During the past 20 years, TVA has purchased and installed 74 hydro-electric generating units in 21 different power plants. Three additional units and two more plants are presently under construction.

These machines vary in capacity from 7000 kw under a head of 58 feet to 67,500 kw under a head of 330 feet. Manufacture and installation of each of these machines has followed a more or less standardized procedure set up by the Authority's personnel. It provides limited running tolerances in shop machining of the shafts and thrust-bearing parts. It also provides a limited misalignment tolerance after the unit is completely assembled in the field.

Items covered in the paper include

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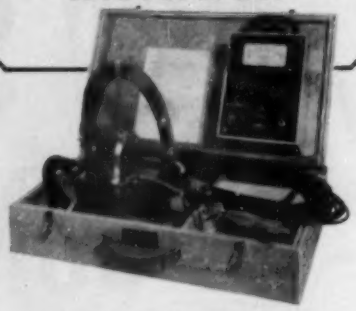

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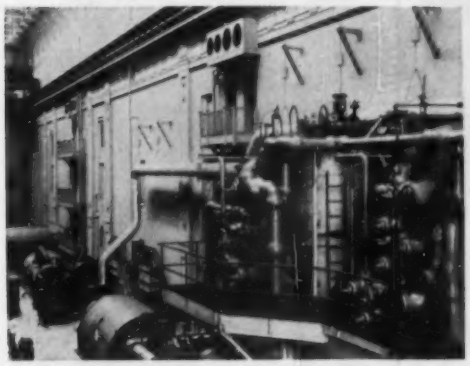
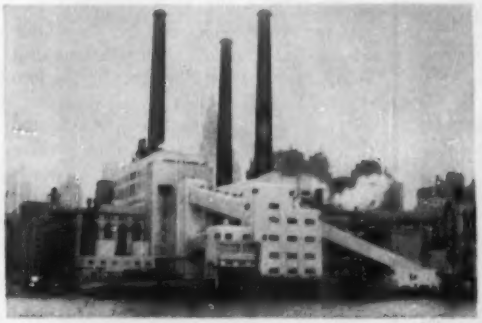


Above, a view of part of the completed ILLCO-WAY Automatic Mixed-Bed De-Ionizer installation at Consolidated Edison Waterside Station, New York City, showing how the ionXchange tanks are ranged along one wall of the turbine room.



CONSOLIDATED EDISON WATERSIDE STATION, N. Y.

This big plant is not only a 100% high-pressure station but, because of large steam sales for skyscraper heating, it has a maximum potential make-up requirement of as much as 2,500,000 lbs. per hour. Water supply and operating conditions were causing the silica concentration in the boiler waters to be of the order of 30 to 35 ppm, resulting in excessive fouling and serious losses. To solve this problem, an automatic mixed-bed de-ionizer system was chosen, after thoughtful analysis and a period of careful pilot-plant tests. The installation has brought the silica in make-up water down to only .01 ppm.

The Mixed-Bed De-Ionizer is one of the most remarkable pieces of water-treating equipment to be introduced since the advent of practical ionXchange. In this system, both anion *and* cation exchange resins are contained in *one* tank, and remain thoroughly intermixed during the service cycle. The result is that the water receives a great number of first cation and then anion exchanges—the equivalent of an enormous number of separate exchange tanks in series. The effluent thus is much more thoroughly "purified" than in the usual single pair of exchangers.

SYSTEM HAS MANY ADVANTAGES

This Mixed-Bed system, which has now been developed into practical form, is particularly effective in the reduction of silica—which makes it of great interest to power plant operators, especially those with high-pressure boilers. In several recent installations, Mixed-Bed ionXchange equipment has proved to be more effective and much more economical than any of the other methods considered. It is also very compact, and requires a minimum of service and maintenance. Operation, after initial tests, is easily established, uniform, reliable, and understandable. Our representatives are equipped to discuss all the possibilities with you, and to make such recommendations as may be justified.

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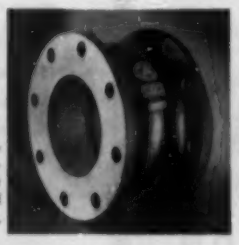
Left: Garlock CHEVRON* Packing used on the Seawolf for stuffing boxes of hull fittings, including periscope, masts, and antenna.

Right: Garlock expansion joint, neoprene lined and covered. This type was installed on the Seawolf's lubrication and fresh water lines.



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More TECHNICAL BRIEFS

Begins on page 156

design and specifications, turbine erection generator erection and rotation check. Experience wth these units shows that with a correct design, any installation in which the mechanical alignment is correct will give trouble-free service mechanically. An installation not in correct alignment will give continuous trouble in overheating, overstressing, fatigue, etc. *AIEE paper no. 55-163.*

Pumped storage and hydro generation at Flatiron power plant. *By S M Denton and H O Britt, Bureau of Reclamation, Denver, Colo.*

Flatiron power and pumping plant is one of a series utilizing the power drop in the transmountain water diversion of the Colorado-Big Thompson Project. The Project diverts water from the Colorado River on the western slope of the Continental Divide to the eastern slope to provide irrigation, hydro-electric power and many other multiple-purpose benefits.

Power installation at Flatiron consists of two 35,000-kva 514-rpm generators driven by Francis turbines, and a two-speed combination motor-generator and pump-turbine unit. Water delivered to the 35,000-kva units under a net head of 1050 feet discharges to the Flatiron tailrace. Water used for generation must also be subsequently used for irrigation purposes.

To release water for generation throughout the year independent of seasonal irrigation requirements, two storage reservoirs receive water discharged at Flatiron. Pump-turbine unit pumps water from Flatiron tailrace into Carter Lake Reservoir.

The two-speed design was adopted when it became apparent that turbine efficiency at expected operating heads could be materially increased by changing to 257-rpm operation when generating. Value of the additional peaking kilowatts made available by the higher turbine efficiency was sufficient to make off-peak over-pumping and peak-load generation a profitable type of daily operation. *AIEE paper no. 55-164.*

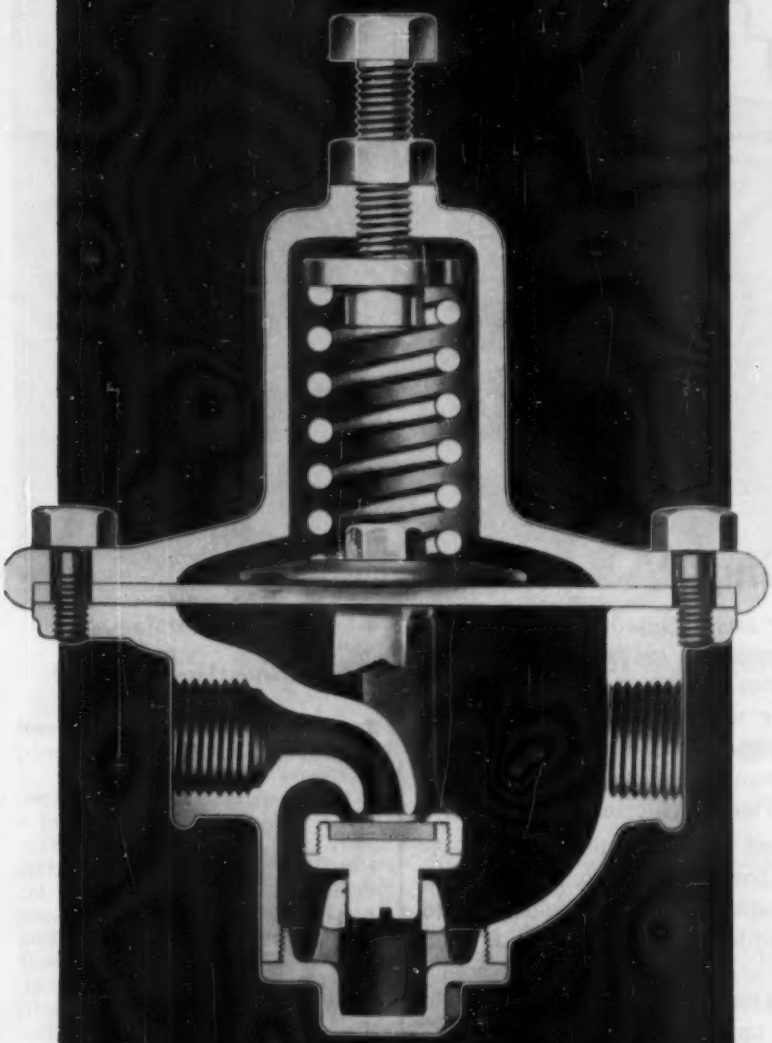
Pumps

Analysis of traction pumps. *F S Weinig, General Electric Company.*

For relatively small delivery volume and relatively high delivery head, the traction pump seems to be quite suitable, especially when cavitation is threatening and when the angular speed of the engine is high. Traction pumps have the disadvantage that the efficiency

Directions for ordering papers on p 238

MASONEILAN No. 227
FOR WATER



Stabilizes

Pressure and Flow

Ideal for either domestic or industrial water lines, Masoneilan No. 227 keeps water pressures stable without cutting down on flow. Stops vibration — reduces strain on plumbing. Eliminates "singing" and spurting from fixtures.

Little or No Maintenance

Built to exceptionally rugged standards, a Masoneilan No. 227 requires little or no maintenance. The heavy-duty fabric reinforced rubber diaphragm lasts indefinitely. Renewable composition disc valve insures tight shutoff. Sturdy bronze body resists corrosion.

Available for initial pressures up to 150 lbs., reduced to pressures between 10 and 120 lbs. Sizes from ¼" to 2". For more information, see your local Industrial Distributor or write Mason-Neilan Regulator Company, 1186 Adams St., Boston 24, Mass.

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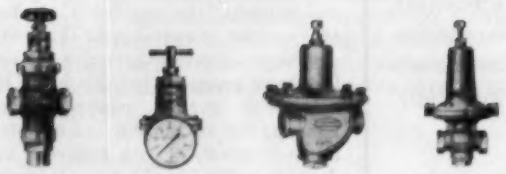


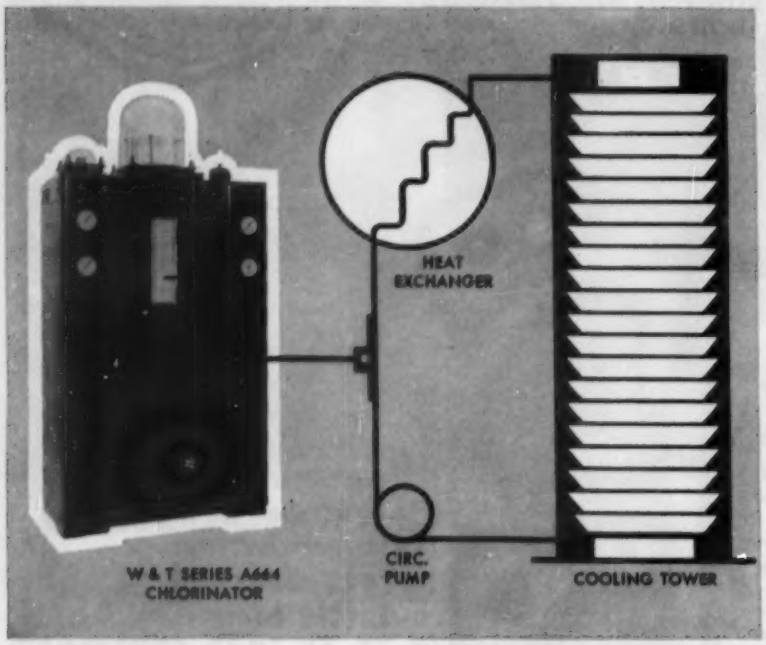
No. 11 for steam No. 71 for air No. 227 for water No. 33 for steam

Order from your Mason-Neilan Distributor.
Use his experience. Save work, save time.

MASONEILAN REGULATORS

Keep Pressure Under Control!

Slime Control...



...Chlorination of Cooling Water Circuits

Heat transfer losses caused by slime formation on condenser and heat exchanger water-side surfaces can be eliminated by chlorination of the cooling water. Water and air-borne organisms—the cause of slime formations—are effectively and economically controlled by Wallace and Tiernan chlorination systems.

The Wallace and Tiernan Series A-664 Chlorinator shown above is one of a complete line of W&T chlorination equipment, designed to give dependable chlorination at all feed ranges. It is used at large plants where cooling water chlorine requirements call for a durable high capacity unit.

We Invite Your Inquiries

Technical information on cooling water chlorination is available in our free booklet, RA-2061-C. Bulletins on chlorination of industrial process water and industrial waste treatment are also available. Write us for your copy.

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CD-40

More TECHNICAL BRIEFS

Begins on page 156

is relatively low. The analysis shows the limits of performance and efficiency as well as means to optimize them. *ASME paper No. 55-SA-35.*

A comparison of regenerative pump theories supported by new performance data. *By Yasutoshi Senoo, Kyushu University, Fukuoka, Japan.*

Several theories of the fluid-dynamic mechanism of a regenerative pump have been presented. The author compares these theories and makes clear the similar and different points among them. In his opinion, the performance of a regenerative pump is influenced by many factors, and one assumption is useful for a certain limited condition but another assumption may be preferable for another condition.

He presents a series of experimental data concerning the geometry of the pumping channel on performance is really complicated, consistent tendencies are found for the influence within the experimental range. These tendencies and experimental data are available not only as an aid to design but also may serve as a guide for the improvement of any simple semi-empirical theory of the regenerative pump as well as for testing any complete theories. *ASME paper No. 55-SA-44.*

Refrigeration

Part load performance in centrifugal refrigeration. *By Arthur M G Moody, The Trane Company.*

Meeting part-load demands poses two major problems to the designer of a centrifugal compressor. The first is the elementary problem of how to operate the machine at all. Because of the minimum-capacity limitation imposed by surging, the compressor, lacking other means of capacity control, would have to shut down frequently, which might well be intolerable. Consequently, it is of paramount importance to find a means to extend the operating range. As soon as this is done, the second problem arises; namely, how to reduce the specific power consumption at part load.

Regardless of the means used to control capacity, the possibility of short cycling must be considered. This would not be so if stable operation at zero load were practical, but this is not the case with present control means. Cycling, that is, starting and stopping, if too frequent, is both annoying and dangerous. The life of a motor is largely dependent on its operating temperature, and frequent starting will raise the

Directions for ordering papers on p 238

Jones & Laughlin *uses many* Fuller Rotary Compressors

Like many other steel producers and fabricators, from the East to the West Coast, Jones & Laughlin Steel Corporation has purchased and uses many Fuller Rotaries in its various mills. Illustrated above is a Fuller Rotary Two-stage Compressor, having a capacity of 1660 c.f.m. 120-lb. pressure, installed in the P-1-10″ bar mill of the Pittsburgh Works Division.

Endurance, plus efficiency and maintained capacity, flow of air without pulsations, elimination of vibration, are results of the rotary principle employed in the design of the Fuller Compressor. They can be placed on comparatively light foundations, on balconies or upper floors to save valuable floor space and shorten distribution lines. Employing a minimum of moving parts—rotor, bearings, blades—greatly reduces maintenance and eliminates adjustments entirely.

The cylinders of a Fuller two-stage machine are at ground level, mounted on a common base plate, and are connected by a flexible coupling. Installation is very simple, the motor being lined up to the coupling on the shaft extending from the low-pressure cylinder. This arrangement simplifies motor maintenance work as compared with many other types of machines.

Due to extremely low inertia and WR^2, Fuller compressors, which operate in speed ranges of 600 to 1750 r.p.m., according to size, and are directly coupled to the motor, may be installed with either a general purpose or a normal torque synchronous motor, as dictated by size and the electrical requirements of the plant. Standard motors are available for all sizes of Fuller compressors in either squirrel cage or synchronous types.

For full information, write for Bulletin C-5A.

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Fuller

PIONEERS OF HIGH-EFFICIENCY VANE-TYPE ROTARY COMPRESSORS

CLEVELAND
SMOKE INDICATORS AND CONTROLS . . .

Provide constant smoke check for oil, gas or stoker-fired boilers

Reduces Smoke · Saves Fuel
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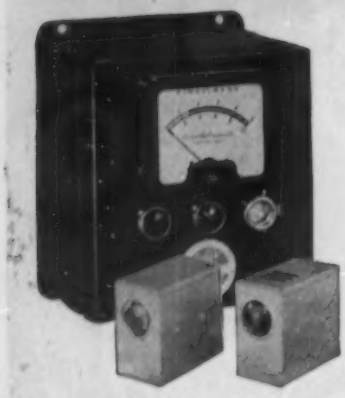


CFE Smoke Indicators and Smoke Controls are photo-electric systems designed to provide a constant check on smoke density, enabling boiler operators to fire at maximum efficiency. CFE Smoke Controllers consist of three components: (1) The Master Control with amplifier, relay, smoke density meter, signal light and adjustments. (2) CFE exclusive light source with integral transformer providing dual voltage and lighting intensity selector. (3) The photo-electric cell receiver.

The Master Control, which may be located remotely, can be set for a pre-determined smoke density — the indicator responds to any variation in smoke density. A time delay circuit permits a small amount of smoke to pass before starting the control to eliminate cycling of equipment.

For complete details on how CFE Smoke Indicators and Controls help end your smoke problems and pay for themselves through increased operating efficiency write to:

CLEVELAND FUEL EQUIPMENT CO.
1111 Brookpark Rd., Cleveland 9, Ohio
In CANADA, write to:
Ontar Laboratories Ltd., 111 Tycos Drive, Toronto

More TECHNICAL BRIEFS

Begins on page 156

temperature. It is impossible to set a definite limit to the frequency of starts, but it is not uncommon to use the figure of three starts per hour as the maximum permissible. This is, of course, arbitrary. Three starts per hour, if continued for many hours, would hardly be beneficial.

Aside from this, it is well known that the wear in sleeve bearings will occur almost entirely at startup, assuming proper lubrication, since this is the only time when there is no oil film present. Hence, excessive frequency of starting ultimately will result in excessive bearing wear. Accepting the limit of three starts per hour, for want of a better rule, and assuming that variations in load are such that long continued cycling at this frequency is unlikely, we can determine what limitations this will impose in any given situation.

Centrifugal refrigeration machines for air-conditioning service are subject to tremendous variations in load. Only for a relatively short period each year is the load close to design value. For extended periods it may be zero or nearly zero. Even within a relatively short space of time it may vary from minimum to maximum values. On the other hand, there may be relatively long periods when the load remains reasonably constant at some value between zero and maximum. The author explains how to resolve the problems involved. *ASME paper No. 55-SA-54.*

TO OBTAIN COMPLETE TEXT

Material for these abstracts comes from the following sources unless otherwise stated. Order complete paper from source, not POWER.

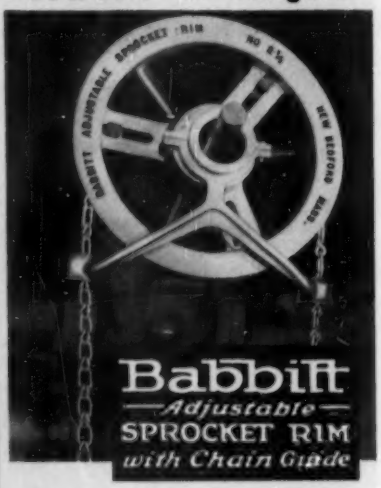
American Society of Mechanical Engineers. Identified by initials ASME and obtainable through ASME, 29 W 39th St, New York 18, New York.

American Institute of Electrical Engineers. Identified by initials AIEE and obtainable through AIEE, 33 W 39th St, New York 18, New York.

American Power Conference, 17th annual meeting. Identified by initials APC and obtainable through purchase from R A Budenholzer, chairman, Illinois Institute of Technology.

Ford Motor Co has awarded Dravo Corp a contract to construct boiler and air facilities to serve their new stamping plant at Chicago Heights, Illinois.

NEW! Re-Designed



ANY VALVE is readily accessible *from the floor* with low-cost Babbitt Sprocket Rim. Now re-designed for —

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Simplifies pipe layouts, prevents accidents, fits all valve wheels. Your supplier carries complete stocks. Call him — or write for folder and prices.

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"See What Goes On Inside"

For insertion into pipe
FOR EVERY APPLICATION
BRONZE, IRON, STEEL, STAINLESS STEEL

FIG. 29 Cylinder with Impeller
FIG. 17-28 Cylinder
FIG. 215 Flanged
FIG. E-57 Double Window
FIG. 212 Visibility Welding Neck or Screw
FIG. E-811 Flapper
FIG. E-1810 Rotating Wheel Type

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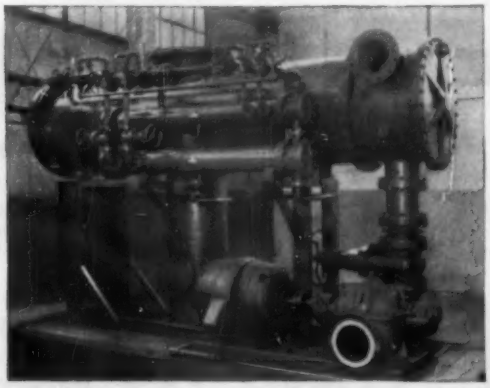

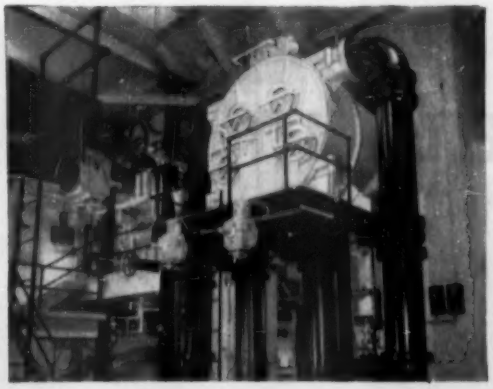

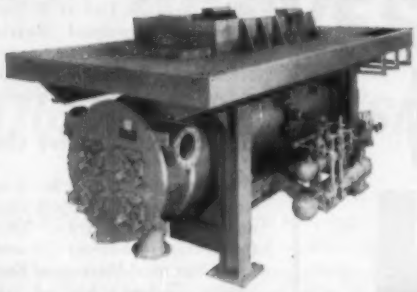

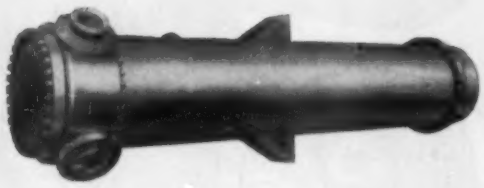

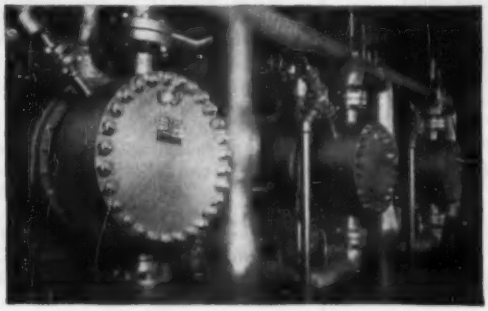

Modern power plants are served profitably by ROSS CONDENSERS and EXCHANGERS *in numerous ways*

Long experienced in diversified condenser and exchanger applications, Kewanee-Ross is a name that is included frequently in plans for modernization.

As a result, modern power plants of today are served by many types of Kewanee-Ross equipment: surface condensers, steam jet ejectors, turbine oil coolers, fuel oil heaters, hydraulic coupling oil coolers, high and low pressure feed water heaters, bleeder heaters, diesel engine lube oil and jacket water coolers, compressor inter and after coolers.

First hand information . . . *the facts* . . . on the numerous ways in which Ross Exchangers and Condensers can serve you profitably will be presented to you promptly by merely requesting a meeting of a Ross engineer with your engineers. There is no obligation.

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RELIABILITY... in the DARLING gate valve picture!

Example: Where severe line condition forces valve seats out of alignment, Darling's unique wedging principle allows discs to adjust tightly against both seats.

THERE'S a sure way of minimizing valve leakage, down-time and a lot of costly maintenance for years on end. Try Darlings!

Darling's *fully revolving double disc parallel seat* principle does the trick . . . by distributing disc and seat wear uniformly, by compensating for valve body distortion, assuring tight closure under the most adverse conditions.

Darling gate valves are made in metals, types and sizes for most services . . . and for pressures up to 1500 pounds. Name your service and write for Bulletin No. 5003.

DARLING VALVE & MANUFACTURING CO.
Williamsport 8, Pa.

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ont.

APPOINTMENTS

Corporation executive changes

Buffalo Forge Co: William R Heath, executive vice-president. **Worthington Corp:** George F Habach, vice-president, engineering. **Stone & Webster Service Corp:** Harold D Beebe, vice-president. **Horizons Inc:** Kenneth M Bartlett, executive vice-president. **Carbide and Carbon Chemicals Co,** a div of Union Carbide and Carbon Corp: D B Benedict, vice-president.

De Laval Turbine Pacific Co: Samuel P Felix, vice-president. **Caterpillar Tractor Co:** G E Burks, vice-president. **Copeland Refrigeration Corp:** Glennon J Doyle, vice-president, operations. **Walworth Co:** Joseph E Mihm, assistant vice-president.

Operations executive changes

Westinghouse Electric Corp: Edward O Edney Jr, project manager for nuclear power program. **The Trane Co:** John D Cantwell Jr, works manager. **National Bureau of Standards:** Samuel Zerfoss, chief of refractories section. **Arizona Public Service Co:** M M Bridgwater, superintendent of operations. **Buffalo Forge Co:** George P Schivley, director of manufacturing.

Engineer changes

A-P Controls Corp: Arthur W Krause, chief methods engineer. **The Foxboro Co:** Vincent V Tivy, chief application engineer. **The New York Air Brake Co:** Frederick L Guyette, chief plant and equipment engineer. **Joy Manufacturing Co:** Robert M Van Tassel, head industrial designer. **The De Laval Separator Co:** Frank E Sullivan, chief engineer, industrial processes.

New sales managers

Bailey Meter Co: Charles F Birchler, manager of central-station division. **Westinghouse Electric Corp:** P T Lagrone, manager of electric utility sales. **The New York Air Brake Co:** R J Murphy, sales manager of Hydreco and Dudco Divisions.

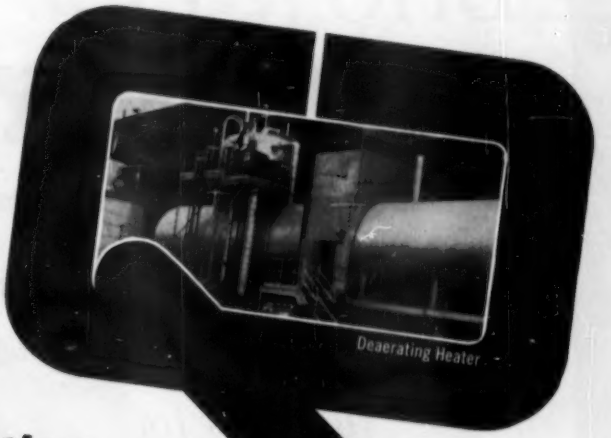
A O Smith Corp: William C Powell, district sales manager for tubular and process equipment division; W M Asher, sales manager for hydraulic products at company's Pacific Coast Works. **Oster Manufacturing Co:** Robert C Baumgartner, general sales manager.

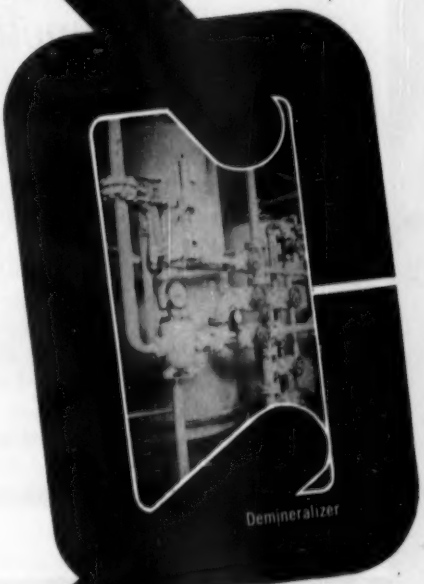
New district managers

Allis-Chalmers Manufacturing Co: Ned W Landis, New York office. **Clark Bros Co:** Charles J Michelson, Tulsa office. **Cochrane Corp:** M C McKeown, Philadelphia office. **Worthington Corp:** Ralph G Griffin, Cincinnati office. **Food Machinery and Chemi-**

GRAVER EQUIPMENT SERVES

Albright Power Station





The new Albright station of the Monongahela Power Co. and Potomac Edison Co. is composed of three units. Two 850 psi boilers each deliver 700,000 # steam per hour and one 1450 psi boiler delivers 1,000,000 # steam per hour. Three generators have a combined plant capacity of 304,000 kilowatts and turn out approximately 200 million kilowatt hours a month.

Graver equipment serves *all three* units. Graver quality of fabrication provides a durable, low maintenance installation. Even more important — Graver supplied the *complete* feedwater treatment system, from major components to accessories. Dependable safety factors designed into all Graver equipment enable it to handle unpredictable surges and reasonable overloads with ease. The Albright installation is typical of those Graver has available to the entire power industry—single responsibility from one source resulting in greater integration of units, greater design uniformity, greater ease of installation.

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Reactivator: 140 gpm • Spray-tray Deaerating Heater: 1,000,000 # per hour • 4,000 cu. ft. storage tank: 100 psig • Two-bed Demineralizer: 65 gpm • Two Gravity Filters: 70 gpm

CONSULTING ENGINEERS: SANDERSON AND PORTER

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Demineralizer WC-111
Reactivator WC-103B

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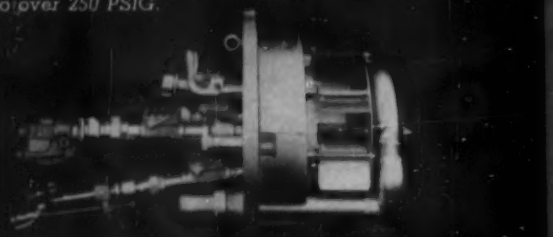
For more than 25 years, Peabody Burners have been successfully used for firing pressurized furnaces on hundreds of critical combustion jobs throughout the world.

Utilizing their years of experience, Peabody engineers have developed burners for pressurized boilers, gas turbines, inert gas generators, high pressure direct-fired air heaters and many other typical applications. Repeated installations, in varying locations, year after year, for many, many clients are your best assurance that Peabody can offer an economical, dependable and efficient product to meet your requirements. We welcome your specific problems.

Peabody burners are used on a wide variety of installations firing into furnaces ranging in pressures from negative to over 250 PSIG.



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More APPOINTMENTS

Begins on page 240

cal Corp, Peerless Pump Division: Robert P Young, New York office. **SKF Industries, Inc:** Phillip A Carlson, Midwestern region. **Walworth Co:** George Newland, Central division.

New sales engineers

SKF Industries, Inc: Holton E Fox, Pittsburgh office. **Edward Valves, Inc:** Earl N Stone, Denver office. **Pennsylvania Transformer Co:** Carl R Boytano, New York office. **Darling Valve & Manufacturing Co:** Donald W Lenzer, Cincinnati territory.

New distributors

For **Botfield Refractories Co:** W P Keith Co, P.O. Box 936, Whittier, Calif. For **Westinghouse Electric Corp,** Sturtevant Division: Forslund Pump and Machinery Corp, Wichita, Kan. For **Ampco Metal, Inc,** Weldrod dept: Buffalo Welding Supply Co, 37 E Ferry St, Buffalo, N. Y.; Randall-Graw Co, 314 Jay St, LaCrosse, Wis.; and Hays Supply Co, 269-287 S Front St, Memphis, Tenn.

For **York-Shipley, Inc:** S C Bratton Sales Engineers Ltd, 2812 12th Ave, N Birmingham, Ala.; The Stromquist Co, Northside Branch, Atlanta, Ga.; Agair Corp, 3454 W Lake St, Chicago, Ill.; James W Vanderpool, Waldoboro, Me.; DeGidio Oil Burner Sales, 3106 Findley Pl, Minneapolis, Minn.; William J Goff & Son, 122 Lincoln Ave, Syracuse, N. Y.; and Tennessee Heating Co, 6005 Magazine Rd, Knoxville, Tenn.

For **Automatic Switch Co:** Control Specialty Corp, 1515 Spring St, Houston 10, Texas; Dearing & Co, 571 Andrews Ave, Youngstown 2, Ohio; Moorlane Co, P.O. Box 2249, Amarillo, Texas; and Frank A Blesso, Inc, 286 Sheldon St, Hartford 14, Conn.

New representatives

For **R P Adams Co, Inc:** James Bush Jr, Framingham, Mass. For **A W Cash Co:** I W Cotton Co, 1842 Central Ave, Indianapolis, Ind.; Fuel Economy Engineering Co, New York Building, St Paul, Minn.; and Keener Sales Co, P.O. Box 1225, Knoxville, Tenn. For **National Valve and Manufacturing Co:** Power Equipment Sales, Inc, 77 Summer St, Boston 10, Mass.

For **American Agile Corp:** Hamilton Associates, 453 N Emerson Ave, Indianapolis, Ind. For **Copeland Refrigeration Corp:** Terrell J Small, Fort Worth, Texas. For **General Precision Laboratory Inc:** Kittleson Co, 416 N La Brea Ave, Los Angeles 36, Calif.; and M P Odell Co, 2536 Euclid Ave, Cleveland 15, Ohio. For **Automatic Switch Co:** Conrad R Bangh, 524 W.O.W. Building, 14th & Farnum Sts, Omaha 2, Neb.

(*Continued on page 244*)

Fiberglas sets world's "elbow-bending" record!

THIS COMPLETE ELBOW COVERING FABRICATED IN ONLY 29 SECONDS!

Simple pie cuts with an ordinary knife produce perfectly fitting segments. No hacking . . . no sawing!

Yes, for speedy handling and fabrication on the job—not only elbows but straightaway runs and odd-shaped equipment, fittings and ducts—Fiberglas* Insulations recognize no equal! Such performance is possible because Fiberglas is light, rigid, non-crumbling, so easy to cut. What a time-and-labor saver! Moreover, it's moisture-resistant and dimensionally stable . . . combines sound absorption with thermal efficiency. Want to test its workability for yourself? Just write, Owens-Corning Fiberglas Corporation, Dept. 186-L, Toledo 1, Ohio.

Fiberglas PF Panels for equipment and ducts possess the same workability as the Pipe Covering illustrated at top of page.

For High Temperatures—KAYLO®, King of High Temperature Insulations. A faultless performer up to 1200° F. Distributed by Owens-Corning Fiberglas Corporation.

Technical data will be found in Sweet's File, Chemical Engineering Catalog and Refinery Catalog.

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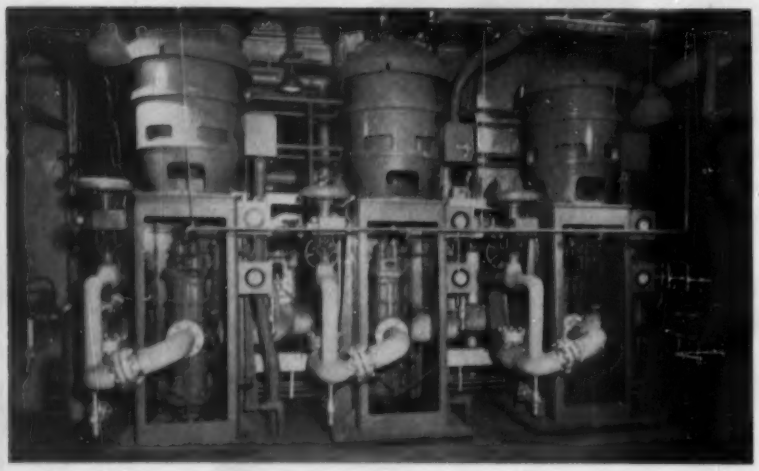
FIBERGLAS

*T. M. Reg. Owens-Corning Fiberglas Corporation
®Kaylo is mfd. by Kaylo Div., Owens-Illinois Glass Co., Inc.

WARREN-QUIMBY SCREW PUMPS USED in the PROCESS of GENERATING STEAM for the WORLD'S TWO HIGHEST TEMPERATURE STEAM TURBINES at

Public Service Electric and Gas Company



ENGINEERING progress marches on and the installation of two of the world's first 1100°F. steam turbines at the new Kearny Station of Public Service Electric and Gas Company in New Jersey, marks another important advancement. Two 145,000 kw. reheat units have initial temperature of 1100°F., pressure of 2350 psig, and reheat temperature of 1050°F. Utilizing these advanced steam conditions results in definitely lower generating costs.

Three Warren-Quimby Gear-in-Head, Vertical Screw Pumps were selected for fuel oil service in connection with this important installation. These pumps are of cast steel with center bearing, and handle Bunker "C" fuel oil at an operating temperature of 125 to 135°F.; viscosity 1500 to 2500 S. S. U.; capacity, 180 g.p.m.; 1150 r.p.m.; suction pressure, 20" Hg. lift; discharge pressure 775 psig.

Keep in step with progress . . . specify: WARREN QUIMBY PUMPS

WARREN PUMPS

WARREN STEAM PUMP COMPANY, INC.

Warren, Massachusetts

More APPOINTMENTS

Begins on page 240

Recent purchases, mergers

A W Cash Co: purchase of business of Farris Stacon Corp. **Walworth Co:** acquisition of assets and business of Alloy Steel Products Co, Inc and purchase of assets and business of Southwest Fabricating & Welding Co, Inc.

U.S. Gasket Co and **Belmont Packing & Rubber Co:** consolidation of product lines, sales organizations and activities under merchandising name of U.S. Gasket-Belmont Packing. **Consolidated Engineering Corp:** acquisition through merger of Consolidated Vacuum Corp, a wholly-owned subsidiary, to be known as ConVac Division of Consolidated.

Recent moves

A G Schoonmaker Co, Inc, executive and engineering offices to Sausalito, Calif. **H E Bovay Jr** to its own building at 5009 Caroline St, Houston, Texas.

Society elections

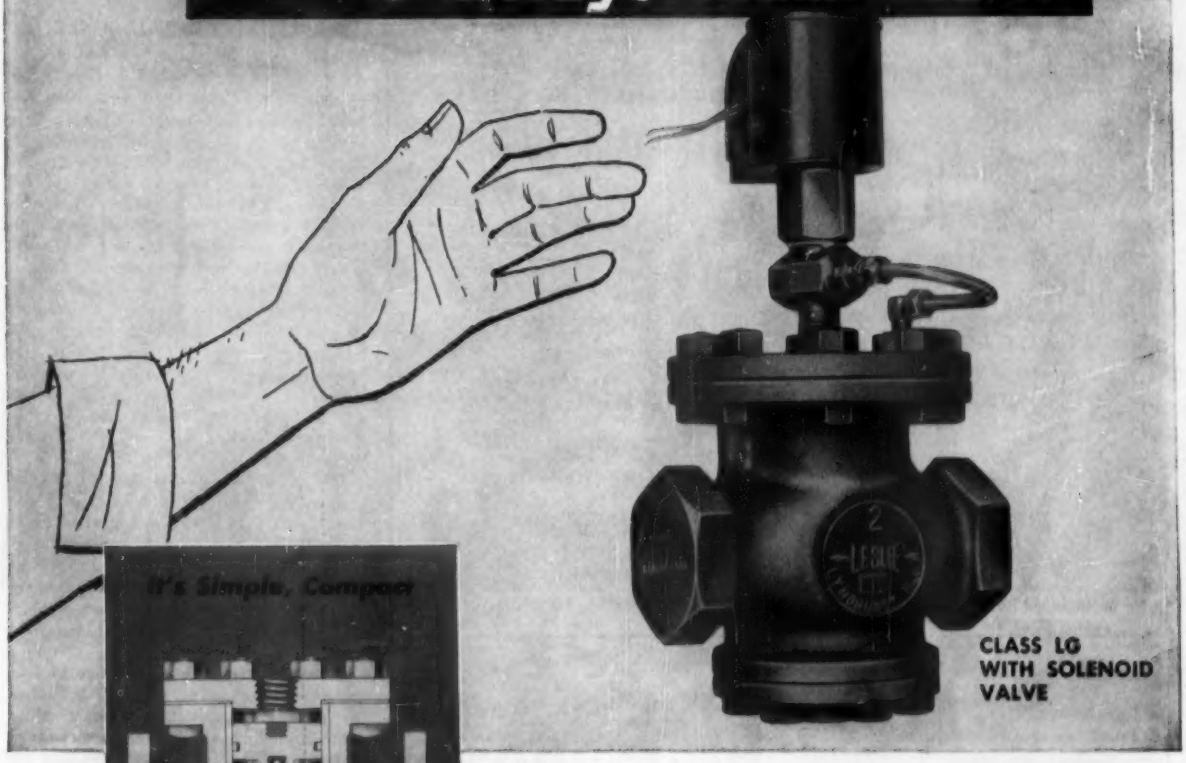
Instrument Society of America: Robert T Sheen, president; Richard N Pond and J Ward Percy, vice-presidents. **American Society of Civil Engineers:** Enoch R Needles, president; Frank A Marston and Glenn W Holcomb, vice-presidents.

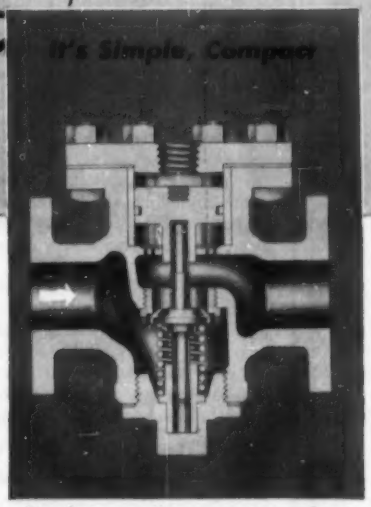
Obituaries

Paul T Dennison, 43, president and one of the founders of Minnesota Rubber and Gasket Co, Inc, September 9th. **Julian B Blasko,** 33, chief engineer of Waters Manufacturing Co; president of Aerohm Corp, October 2nd. **Lincoln Kilbourne,** 44, general manager of sales, industrial division, of The Jeffrey Manufacturing Co, October 5th. **H L MacElroy,** general sales manager of Springfield Boiler Co, October 7th.

"When an alarm rings we see what's wrong . . . we don't hide!"

This operating valve is *always* within *reach*





Simplicity and compactness keep cost *down*, reliability *up* in this Leslie Class LP operating valve.

Make a demand — the valve obeys. It's like having a third hand and a long arm as the control for this shut-off valve is *always* within *reach*.

You can get Leslie shut-off valves equipped with an electric solenoid valve (Class LG) or you can operate them remotely (LP) with air or hydraulic relay valve. Valve opens and closes on demand of a manual or automatic signalling device (pressure switch, thermostat, etc.)

Designed for off-on service, there are units with body ratings to 1,000 psi and temperatures to 750°F. The valves give fast, tight shutoff of steam, air and non-corrosive fluids.

Ask your Leslie engineer to help you select the operating valve that's engineered to meet your service requirements. You'll find him listed under "Valves" or "Regulators" in your classified telephone directory.

Bulletin 5309 describes operating valves.
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special report, published in December, will bring you up-to-date on the big topic of our times

Atomic Energy.

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BOOKSHELF

Manufacture and Application of Lubricating Greases. *By C J Boner, Chief Research Chemist, Battenfeld Grease and Oil Corp. 6x9, 977 pp, cloth, illust, $18.50. Reinhold Publishing Corp, 430 Park Ave, New York 22, N. Y.*

This book describes fully the structure and theory of lubricating greases and devotes full chapters to all raw materials, processes and manufacturing equipment. Lubricants containing specific thickeners and additives, including such new developments as lithium soaps, complex soaps and non-soap gelling agents, receive detailed attention. Emphasis is placed on effects of each ingredient or treatment upon the characteristics of the final product, and the methods of evaluating these characteristics by either chemical or physical means.

The final chapters deal with application of, and trends in lubricating greases.

Industrial Power Systems Handbook. *Edited by Donald Beeman, General Electric Co. 6x9, 971 pp, cloth, illust, $12.50. McGraw-Hill Book Co, Inc, 330 W 42nd St, New York 36, N. Y.*

Design of electric power distribution systems for industrial and commercial installations is fully detailed in this book. Sixteen specialists cover the major phases of power system design, with explanations of fundamentals and methods, worked-out illustrative examples and a variety of helpful data drawn from General Electric Co experience.

Included among the wide range of subjects is information on short-circuit protection, methods of voltage regulation, equipment grounding, allowable system voltage variations, effect of design problems on flexibility and economy, and costs of various power systems.

The book reveals how to modernize and expand existing power systems and suggests practical methods for applying modern power principles to commercial and office buildings. Numerous examples and case histories are given to illustrate modern industrial and commercial power system practices.

National Fire Codes. *(1955 Edition). Six volumes, 172 separate standards, total 4100 pp, ea 5½ x 8½, cloth. $6 per volume. National Fire Protection Association, 60 Batterymarch St, Boston, Mass.*

The 1955 volumes have a total of 43 changes, incorporating all new and revised safety standards adopted at the 1955 NFPA Annual Meeting and all amendments approved up to July 30, 1955.

The Fire Codes are intended as a guide for achieving reasonable safety to life and property, while avoiding inconvenience and expense not essential to practical fire safety.

Although purely advisory, the Codes are widely used in the U.S., Canada and abroad. They are prepared by 100 technical committees representing the general public, government, industry and insurance. Many are adopted and published as official standards of the National Board of

It takes a total of 12,600 hp to operate these 24 pumps that supply the 2500 psi water for press operations.

This Hydraulic Piping speeds shell production

Water at 2500 pounds pressure surging through this piping system helps squeeze out 155 millimeter and 8 inch shells. This is how production is activated at the new government-owned Scranton Ordnance Plant, operated by United States Hoffman Machinery Corporation, Scranton, Pennsylvania.

The high pressure water supply that operates the hydraulic shell forming presses comes from this battery of twenty-four pumps. When using the presses, water surges through the system in jolts to meet the press demands. Such rugged service requires foolproof piping fabrication as a failure could be disastrous.

To guard against any possible failures from these extreme pressure variations, the piping system was thoroughly inspected and tested, at pressures well above what might be encountered. Fabrication was done in Dravo's Marietta, Ohio, piping plant with erection being completed under the close supervision of Dravo field fabrication specialists, so that uninterrupted performance is assured under the severest of service.

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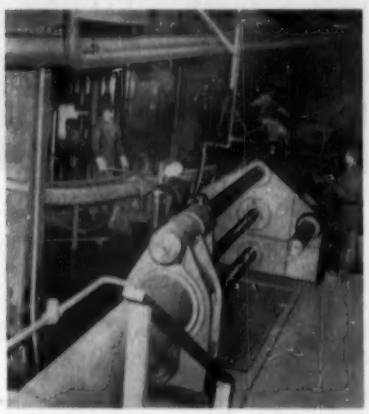

View of actual press operations in the forming of 8" shells. Large diameter pipe feed lines were anchored every 10 ft. to guard against shaking loose.

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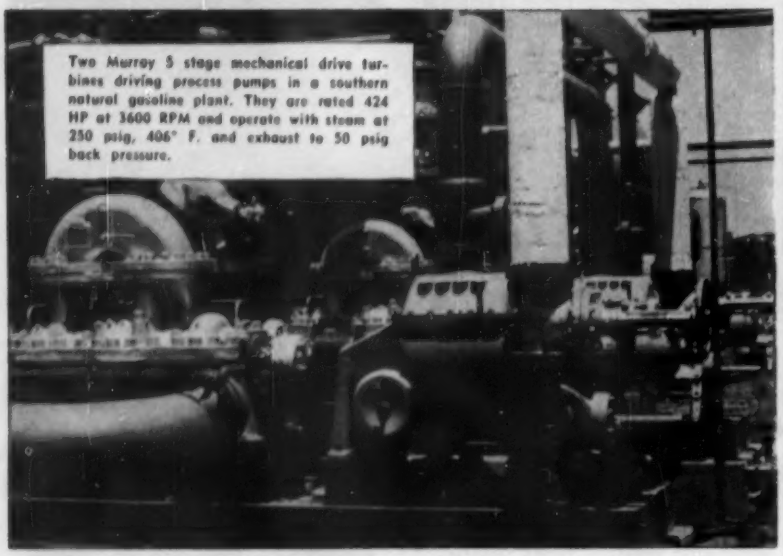

Two Murray 5 stage mechanical drive turbines driving process pumps in a southern natural gasoline plant. They are rated 424 HP at 3600 RPM and operate with steam at 250 psig, 406° F. and exhaust to 50 psig back pressure.

● Murray turbines for mechanical drive can be furnished for various combinations of the following conditions:

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Speeds up to 11,000 RPM

Steam up to 600 psig, 750° F.

Back pressures up to 300 psig., or condensing

● Murray mechanical drive turbines are built in various combinations as follows:

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Single governor valve with or without hand valves

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MURRAY IRON WORKS COMPANY

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More BOOKSHELF

Begins on page 246

Fire Underwriters, the Dominion Board of Insurance Underwriters and other organizations.

Contents of the six volumes are: Vol 1—Flammable liquids and gases, 36 standards, 828 pp; Vol 2—Combustible solids, dusts, chemicals and explosives, 33 standards, 554 pp; Vol 3—Building construction and equipment, 33 standards, plus a discussion of building codes and references to model codes, 672 pp; Vol 4—Extinguishing equipment, 32 standards, 936 pp; Vol 5—Electrical, National Electrical Code with corrections, interpretations and interim amendments to date, plus six other NFPA electrical standards and a digest of electrical provisions of 68 other NFPA standards, 672 pp; Vol 6—Transportation, 21 standards, 476 pp.

Diesel Operator's Guide. *By C Morgan Jones. 389 pp, illust, $6.50. McGraw-Hill Book Co, Inc, 330 W 42nd St, New York 36, N. Y.*

Material presented in this work serves as a practical guide to quick and efficient maitnenance and operation of all diesel engines used in automotive, stationary and marine installations. Basically, this book tells how to (1) recognize engine-trouble symptoms (2) diagnose their cause (3) remedy the defect and (4) prevent its recurring. It tells the diesel operators and maintenance men how to go about doing any particular job from timing a fuel pump to planning a cooling-water system.

Latest diesel-engine developments are covered. Such topics as dual-fuel and heavy-fuel engines, inter-cooling, after-cooling and supercharging are discussed in detail. In addition, there are chapters on the newest types of fuel pumps, engine governors, intake and exhaust systems, engine drives and engine foundations. A roundup of information on fuel storage and engine maintenance schedules is also included.

Hydraulic Research in the United States. *Edited by Helen K Middletown, National Bureau of Standards Miscellaneous Publication 215. 198 pp, $1.25. Government Printing Office, Washington 25, D.C.*

Information contained in this publication was compiled from project reports by various hydraulic and hydrologic laboratories in the U.S. and Canada. Projects included are sponsored by private industry, universities and the Government. All projects are in an active state, unless otherwise noted, and many listed in this volume are reported for the first time.

Research projects are reported by title and carry a number which is kept throughout the project history. Other information includes the project sponsor, project correspondent, nature of the project, a brief description, present status, results obtained and publication.

Public Service Co of Colorado has broken ground for a $19 million 100,000-kw steam-electric generator station in Denver.

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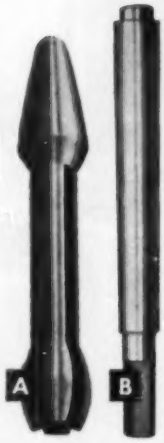

A Tube Pilot guides tubes through baffles and far sheet when retubing.

B Tube Knockout tool for manual or mechanical use.

It makes good sense to buy the Wilson Tube Cutter and accessories. For some more suggestions that will cut your tube maintenance costs, write for Wilson comprehensive Tube Expander Catalog. For tube cleaners, send for Wilson Catalog 77.

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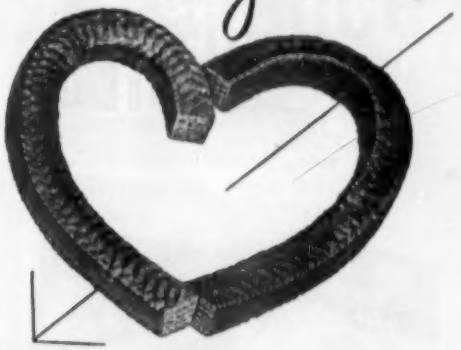

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For the highest speed centrifugal pumps—or any other application where pliability and high wear resistance is required . . . PALMETTO'S latest packing development has all this plus those features that have made PALMETTO the leader in the quality packing field.

As in all PALMETTO Self-Lubricating Packings, each strand is saturated separately *before* braiding, thus assuring complete and uniform lubrication of the *whole* packing. A reservoir of lubricant is "braided in" to make perfect sealing and long service life a certainty.

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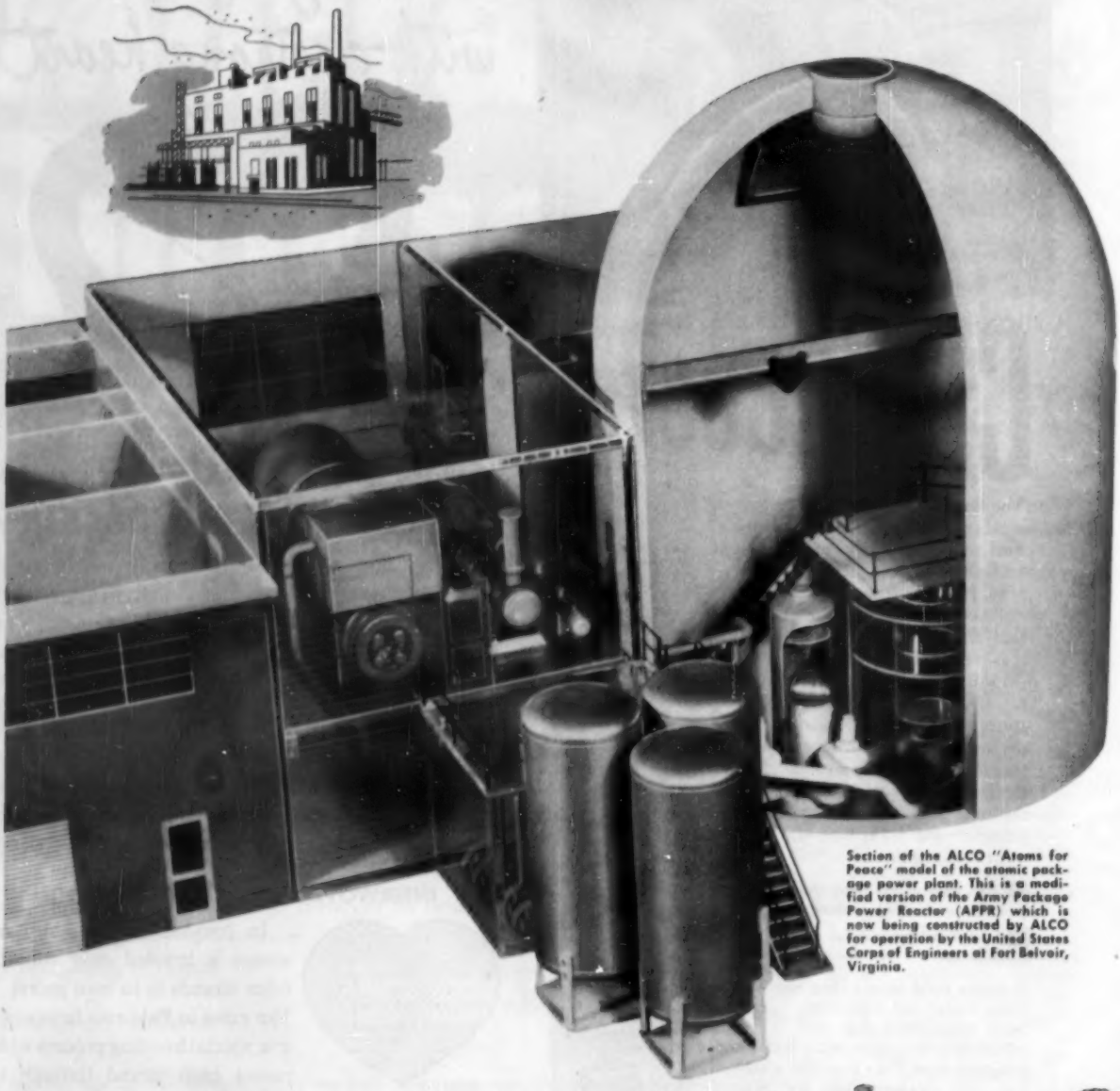
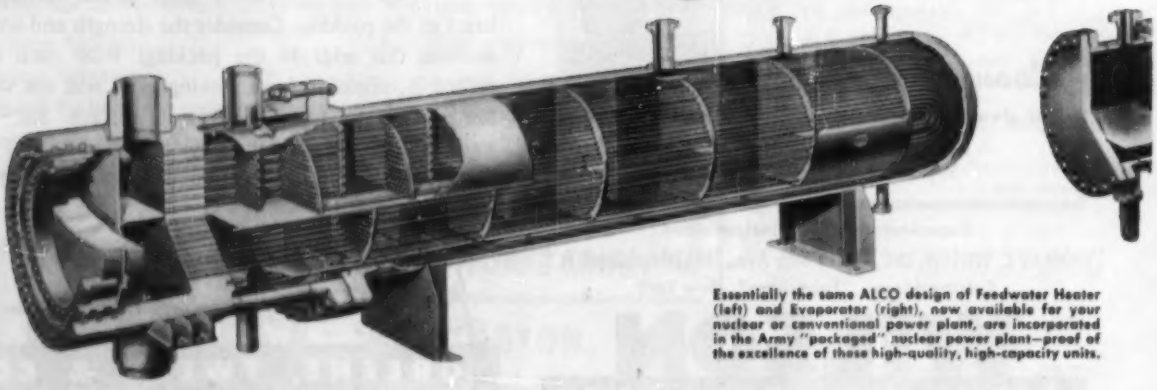
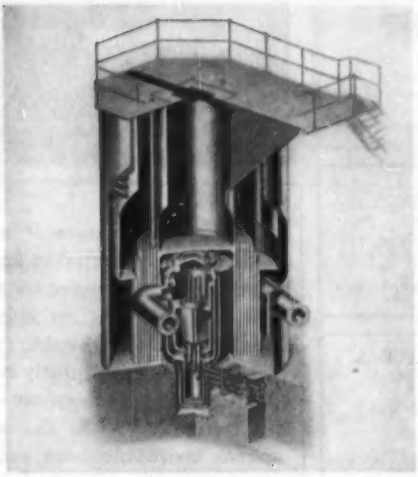


Section of the ALCO "Atoms for Peace" model of the atomic package power plant. This is a modified version of the Army Package Power Reactor (APPR) which is now being constructed by ALCO for operation by the United States Corps of Engineers at Fort Belvoir, Virginia.



Essentially the same ALCO design of Feedwater Heater (left) and Evaporator (right), now available for your nuclear or conventional power plant, are incorporated in the Army "packaged" nuclear power plant—proof of the excellence of these high-quality, high-capacity units.

Power Plant Equipment ...rely on Alco Experience



Reactor, reactor vessel, and primary shield designed by ALCO for the Army "packaged" nuclear power plant. Shielding consists of concentric steel cylinders separated by layers of water.

Whether you are planning ahead to nuclear power or expanding along conventional power lines, ALCO can help you.

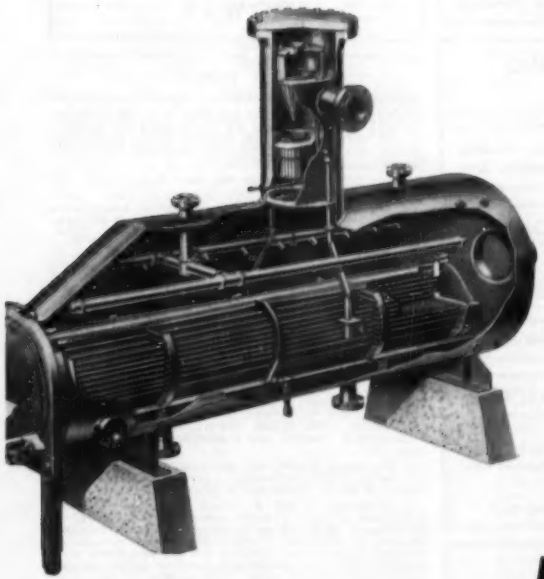
Our experience includes meeting the exacting heat transfer requirements of more than 100 power plants throughout the world. With this broad background, ALCO's introduction to the field of nuclear power has been a natural one.

Since 1949, ALCO has produced many components for the Atomic Energy Commission — heat exchangers for the Nautilus and for AEC plants as well as nickel-plated pipe, among other products — and is now building the first Army "packaged" nuclear power plant.

In the nuclear power field, ALCO offers design, engineering and fabrication of reactors, reactor vessels, steam generators, heat exchangers, feedwater heaters, evaporators, condensers, pressure vessels, and fuel handling equipment and components for all types of plants.

Put ALCO's experience to work for you — whatever your power plant needs. Call your nearest ALCO Sales Office for complete details on nuclear reactors, feedwater heaters and evaporators. We will be glad to discuss your power plant equipment problems.

Be sure to see ALCO's exhibit in Booth No. 307 at the Atomic Exposition being held December 10th through 16th at Cleveland's Public Auditorium.



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[SEAL] ELVA G. MASLIN
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Position Vacant Power plant superintendent for a municipal steam electric generation plant. Present average load 3200 KW. Plant in good condition. Must understand full operation and be able to direct personnel. Apply to Carl W. Fuehrer, Borough Manager, Ephrata, Pa. giving qualifications, salary expected, availability for interview and date position could be accepted.

Consulting Engineering firm located on West Coast of Canada requires junior steam engineer. Good opportunity for right man. Reply P-8194, Power, stating qualifications and salary expected.

Mechanical Engineer—Preferably with heating and ventilating and/or steam power experience for work with engineering firm serving the Northwest. Pleasant offices in medium sized college town. Work to include studies, design and general supervision of construction. Give details of experience and salary requirements in letter to Cornell, Howland, Hayes and Merryfield, 1600 Western Avenue, Corvallis, Oregon.

Senior electrical engineer required for promi-nent consulting engineer firm located on West Coast (Canada). Pulp and paper mill experience required. Reply P-8190, Power, giving qualifications, salary expected and availability.

Engineer have fine opportunity for a young graduate engineer in a high pressure industrial power plant. Experience preferred though not required. Write stating education, experience, salary requirement, and recent snapshot if available. Location Texas Gulf Coast. P-8289, Power.

West Coast (Canada) Pulp and Paper Consult-ing Engineer Firm requires Senior Engineer specialized in power plant design, preferably including recovery boiler experience. Reply P-8187, Power, giving qualifications, salary expected and availability.

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Power Engineer, age 31, technical education 12 years experience licensed chief engineer, complete resume on request. PW-8270, Power.

SERVICE ENGINEERS

Expanding midwestern manufacturer of power and process instruments and control equipment in lakeside city of 30,000 with excellent schools, recreational facilities and residential areas offers permanent positions to two graduate Electrical, Mechanical or Chemical Engineers.

Familiarity with steam power plant operation and instrumentation essential. Work involves field calibration and adjustment of Hays equipment preparatory to placing it into operation and instructing users.

Position requires men with high degree of initiative who are capable of working and seeing jobs through without direct supervision. Salaries and possibilities for growth and advancement excellent for qualified Engineers.

Send resume to Personnel Director

THE HAYS CORPORATION
MICHIGAN CITY, INDIANA

Senior Electrical Engineer, married no family, age 45. Technical education, 15 years experience in electrical distribution of Public Power Supply Company in Europe. During this period ten years night school teaching experience, 10 years experience with oil companies: a) in South American Refinery and b) in Far Eastern Oilfields. Generation and distribution. Planning and administrative experience and ability. Speaks Spanish, French and German. Desires position as Chief Engineer, assistant to management, etc. Available for personal interview as from 1st March 1956. PW-8274, Power.

Chief Marine and stationary Engineer, experi-enced all phases maintenance, operation and administration, age 33, seeks responsible position. PW-8275, Power.

SELLING OPORTUNITY WANTED

Heavy industrial boiler plant equipment ac-count for New York Metropolitan area or Northern N. J. to complement present line of boiler feedwater treating equipment. Foster Equipment Co., 145 Sussex Rd., W. Englewood, N. J.

When Writing Your Ad

Provide an indexing or subject word.

Write it as the first word of your ad.

If it is a Position Wanted or Position Vacant ad, make the first word the kind of position sought or offered.

This will assure proper classification in the column.

The right is reserved to reject, revise or properly classify all Want Advertisements.

Proper Classification increases the possibility of Prompt Returns

POWER PLANT PERSONNEL

A middle east coast utility now constructing a new high pressure, pulverized fuel generating station will accept applications for employment from qualified persons for the following positions, which are available immediately.

Results or Test Engineer

Must be graduate mechanical engineer or equivalent, with experience in modern power plant operation and three years in a responsible supervisory results position. Will be required to assume full charge of power plant testing, chemical control, accounting and research.

Power Plant Electrical Foreman

Excellent job for a man who has had extensive experience in handling a group of electricians in the maintenance of all electrical equipment in large power plants or substations. Must be able to organize and schedule work and be thoroughly competent to direct trouble shooting on complicated control systems and relaying.

Power Plant Chemist

To assume full charge of modern laboratory. Must be experienced and thoroughly conversant with the analysis of water, fuel and lubricating oils. Must know water softening and conditioning in a large water treating plant, and be able to interpret test results into instructions to operators for correction of unusual conditions.

Assistant Results or Test Engineer

Graduate mechanical engineer or equivalent, with experience in power plant test and technical work. Will conduct tests and research and maintain records under direction of the Results Engineer.

Job is located near excellent residential community, good working conditions, forty hour week (paid vacations, insurance, sick pay and retirement plan).

High caliber men are needed to fill the foregoing jobs, and for applicants meeting the above requirements, consideration will be given to reimbursement of expenses incurred for the moving of household goods and personal effects.

All personnel selected will receive training at full pay in order to familiarize themselves with the plant before assuming their duties. Include a complete resume of experience and qualifications in first letter. All applications will be treated confidentially.

P-8299, POWER
330 W. 42 St., New York 36, N. Y.

WANTED
POWER PLANT SUPERINTENDENT
PULP & PAPER MILL

M.E. or E.E. graduate with experience on high pressure boilers, turbo-generators, pulverized fuel. Send resume and salary requirements. Replies confidential.

P-8397, POWER
520 No. Michigan Ave., Chicago 11, Ill.

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES · EQUIPMENT - USED or RESALE

UNDISPLAYED ——RATES—— *DISPLAYED*

(Not Available for Equipment Advertising)

$1.65 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.
Box Numbers count as one line.
Discount of 10% if full payment is made in advance for 4 consecutive insertions.

The advertising rate is $17.90 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.
An advertising inch is measured ⅞" vertically on one column, 3 columns, 30 inches to a page.

Send new ads to POWER, 330 W. 42 St., New York 36, N.Y. for January issue closing December 6th.

DESIGN ENGINEERS

PERMANENT OPPORTUNITIES WITH McKEE

IN OUR REFINERY, METALS OR INDUSTRIAL DIVISIONS AT OUR CLEVELAND, OHIO OFFICES

McKee with more than 50 years of successful operation, doing business all over the world; is one of the largest, oldest and best known engineering and contracting firms in the business. The McKee organization continues to grow and expand, thereby offers many present and future opportunities for qualified and experienced engineers and designers in the following fields:

PIPING • STRUCTURAL STEEL
CONCRETE • PROCESS HEATERS
EQUIPMENT SPECS.
ALSO
Electrical Drafts • Layout Engineers
Process Engineers

Applicants should have at least five years' of experience.

Here is a rare opportunity for you to utilize your engineering abilities and talents.

McKee offers top compensation commensurate with experience and ability. No age limitations.

Transportation & Moving Allowances.

Please Send Resume to: EDWARD A. KOLNER

ARTHUR G. McKEE & CO.
2300 Chester Ave., Cleveland 1, Ohio

UTILITY ENGINEER

Excellent opportunity for a man looking for more responsibility and a chance to grow with an expanding Division of General Motors.

Should be capable of supervising the operations and maintenance of boilers in excess of 100,000 lbs. per hour, air compressors of 1,000 horsepower or more, gas generating and auxiliary equipment. Must be graduate engineer, mechanical preferred. Five years minimum experience in supervision of maintenance and operation of steam generating equipment. Knowledge of air compressor and gas generator operation and maintenance desirable.

Send letter and resume to:

Salaried Personnel Department
ROCHESTER PRODUCTS DIVISION
GENERAL MOTORS CORPORATION
1000 Lexington Avenue
Rochester 3, New York

HYDRAULIC TURBINE SERVICE

Cavitated and Damaged Runners Repaired

Cast Iron, Cast Steel,
Bronze and Stainless: Emergency
Services: Inspection and Supervision
Services: 30 years experience

- Use of Stainless Steel for cavitation repairs for long life
- Work performed in place on runners where damaged areas are accessible
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SERVICE ANYWHERE
Write for Bulletin No. 501

Welding Engineers, Inc.

Norristown, Pa. **Phone: 8-6900**

Prepare for
REFRIGERATION LICENSE

More than 300 multiple choice questions from past exams. Many sketches. 96 pages 8½" x 11". Send $3 to:

W. D. TURNER
44 West 63rd St., New York 23, New York

WANTED

Steam Engine Generator Sets • Turbines • Condensers • Generators • Boilers • or Complete Power plants.

PAUL OBERMAN
1910 Delmar **St. Louis, Mo.**

WANTED
STEAM GENERATOR UNIT

Size 150 to 250 KW. Current 3-60-220 Preferred.

MARYLAND MACHINERY EXCHANGE
HAGERSTOWN, MD.

-TRANSFORMERS-
BOUGHT AND SOLD

We carry a large stock of rebuilt and guaranteed transformers, and invite your inquiries.

Custom-built transformers and coils manufactured to your specifications.

Expert Repair Service—all makes and sizes of transformers rewound, repaired and redesigned. Ask for our price schedule.

THE ELECTRIC SERVICE CO., INC.

5318 Hetzel St. **Cincinnati 27, Ohio**

40 Years' Dependable Service

BOILERS FOR SALE

New unassembled B & W Marine type "D" 44,500 lbs/hr., 450# design complete with normal trim.

C-E 4 drum Stirling Type 233# design, 55,000 lbs/hr., complete. Used.

BOILER WANTED

One used 250 HP Erie City type VL or Keeler Type CP.

FURNACE CONSTRUCTION CO., INC.

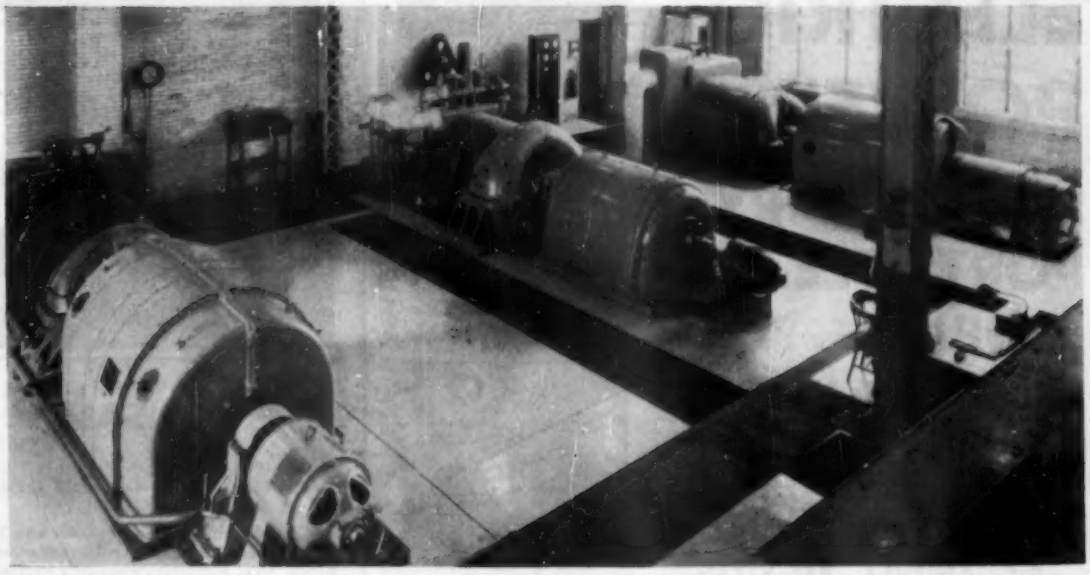
Box 634 **Redmond, Washington**

HYDRO-ELECTRIC GENERATING UNITS
2—UNITS—350 KW—600 VOLT—20 FT. HD
1—UNIT—500 KW—2300 VOLT—28 FT. HD.
1—UNIT—500 KW—2300 VOLT—30 FT. HD.
All units good condition complete with switchgear can be delivered loaded to R.R. cars at $25.00 per KW or less. For complete information.

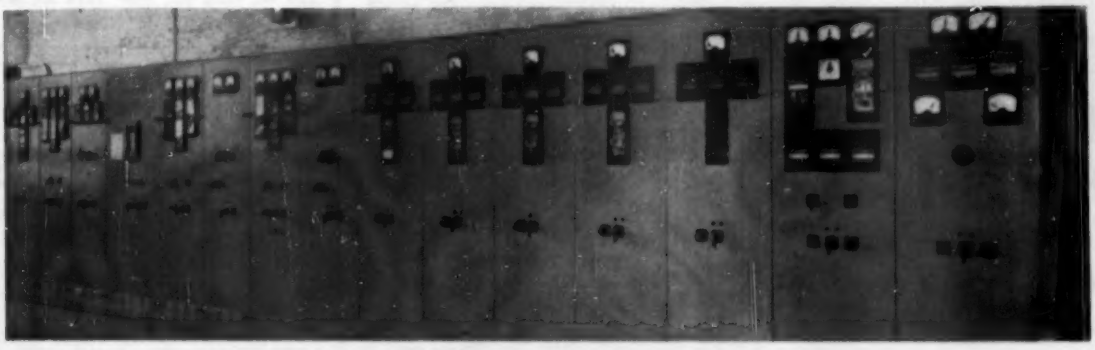
SORENSON GOVERNOR SERVICE
264 KOSSUTH ST., BRIDGEPORT, CONN.

If there is anything you want
that other readers can supply
OR . . . something you don't want—
that other readers can use—
Advertise it in the
SEARCHLIGHT SECTION

3750 KVA, 2500 KVA, Westinghouse & 1563 KVA G. E. Turbine-Generators



Above Turbine-Generators are all 400# PSIG, 750 Degrees FTT 3/60/2300 V., equipped with 2-pass Surface Condensers, direct-connected Exciters, complete with all parts and fittings. Serial Number of Westinghouse Turbine, 3750 KVA, is #5-A-3107-1, new 1949. Other units rebuilt and pressures changed to 400# PSIG in 1948. All units are in good operating condition; just came out of service 30 days ago and are still on foundations.



ABOVE IS THE SWITCHBOARD SERVING THESE UNITS

We own above equipment outright. Will sell it complete, as shown, or will sell each unit separately.

PHONE
WRITE
OR WIRE

CHARLES WEAVER
19701 JAMES COUZENS HIGHWAY
DETROIT 35, MICHIGAN

TELEPHONE:
BROADWAY
3-1901

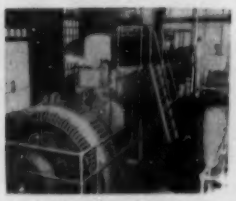
DIESEL ELECTRIC POWER

STATIONARY PORTABLE MOBILE

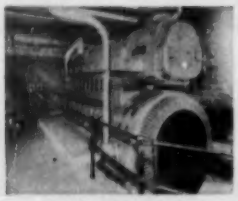
100 KW TO 1500 KW ENGINEERED DIESEL POWER

A.C. AND D.C. ALL SIZES

Cleveland Cliffs Iron Works



Hawaiian Pineapple Company



Municipal Power Plant
Herkimer, N. Y.

SPECIALISTS IN DESIGN FOR YOUR REQUIREMENTS

WRITE FOR BROCHURE

A. G. SCHOONMAKER CO., INC.

Box 516, Sausalito, Calif. • 50 Church St., New York 7, N. Y.

COMPRESSOR DIRECTORY

World's Best Rebuilts

All Makes
Many Sizes

Electric
Steam
Gas
Diesel

AIR

Since 1902

Air for Sale or Rent

1 CFM to 5700 CFM
1 lb. to 3500 lbs.

American
AIR COMPRESSOR CORP.
[illegible] AVE. & 47th ST.
NORTH BERGEN, N.J.
Telephone UNion 5-4848

FOR SALE

Operating diesel plant—Fairbanks Morse type 32E, 300 RPM, two cycle, 3 phase, 4 wire, 60 cycle, 220/440 volt.

Consisting of one: one 2 cylinder with 121 KVA generator and one 3 cylinder with 312 KVA generator. Woodward governor, synchronizer, pumps, oil purifiers, power panels, exciters, exhaust silencers, fuel tank and cooling radiators.

All very well maintained and in excellent condition. Low current and maintenance cost outfit. Can be inspected running. Good for many years full use or indefinitely as standby.

FS-7865, POWER
330 W. 42nd St., New York 36, N.Y.

BARGAINS

3—2160 KW BUSCH-SULZER DIESEL GENERATOR SETS, 3/60/4160/2300, complete. New 1942. Can be seen operating.

1—300 KW G.M. 8-268A DIESEL GENERATOR SET, 3/60/480. Radiator cooled, portable.

3—300 HP KEWANEE BOILERS, 125 PSI. NEW 1942.

2—150 HP UNION WATER TUBE BOILERS, 160 PSI.

1—250 HP STIRLING BOILER, 150 PSI.

3—4'x135' STEEL STACKS, welded.

PHONE—WIRE—WRITE

HEAT & POWER CO., INC.
60 East 42nd St. New York 17, N. Y.
Murray Hill 7-5280
(Machinery & Equipment Merchants)

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3 G. M. 200 KW DIESEL GENERATOR SETS

Reconditioned by U.S. Navy

EQUAL TO NEW

Complete with motor driven starting air compressors, air tanks, dead front type generator switch panels and all other necessary accessories.

ENGINES

G.M. Model 8-268A—6½x7—1200 RPM—air starting—complete with engine operating panels, heat exchangers, cooling pumps, filters, strainers, governors, pyrometers, etc.

GENERATORS

Westinghouse 200 KW 250 KVA—440/3/60—1200 RPM—80% P.F.—continuous—drip-proof enclosure—direct connected exciter.

SIZE AND WEIGHT

Each unit, mounted on a pre-fab sub-base, is 13' 9 5/16" long, 3' 10½" wide, approx. 8' high. Weight of engine and generator only, 17,705 lbs. Each unit, with all accessories, about 27,000 lbs.

CONDITION

No expense has been spared to put these 5 units in "equal to new" condition. Don't miss this opportunity to buy! Inspection can be made at our warehouse, Curtis Bay, Baltimore.

THE BOSTON METALS CO.
313 E. BALTIMORE STREET
BALTIMORE 2, MD CURTIS 7-5050

FOR SALE
18 NEW TURBINES

4 horizontal, 14 vertical, Westinghouse

Driving forced draft blowers—capacities ranging from 39000 to 56000 CFM and 16" to 24" pressure. Steam pressures 360 to 575#, back pressure 10#.

Will sell turbines separately if desired. *Price reasonable.*

Also—1—250 KW GE turbo generator unit, 3 phase, 60 cycle, 440 volt. Used one year.

G. M. DeROSE
2457 WOODWARD AVE.
408 DONOVAN BLDG.
DETROIT 1, MICH.

LIDGERWOOD HOIST

Serial #8001. 250 H.P. 2300 volt slip ring motor drive Hoist designed for 350 f.p.m. of 1⅞" rope. Face of drum 55-9/16", diameter to bottom of groves, 84" Electric brake connected. Split drum, all steel base, Blue prints available.

2000 KVA G.E. type H. T. Form D.H. 66,000/22000/2300/60 cycle. Serial #4540898.

ELJAY INC.
L. J. LAND, Pres.
401 Broadway, New York 13, N.Y.
Telephone WOrth 6-0969

BELYEA RE-NU-BILT

LARGE ELEC. POWER EQUIPMENT

SELECTED STOCK ITEMS

RE-NU-BUILT—GUARANTEED—RE-NU-BILT
COMBINATION MILL DRIVES — 15/2500 HP
D.C. MOTORS WITH M.G. SETS & CONTROLS

	MAKE	TYPE	VOLTS	R.P.M.
2200 HP	G.E.	MCF-12	600	400/500
2000 KW	G.E.	Syn.	2300/4000	514
1400 HP	G.E.	MCF14	600	63/100
1500 KW	G.E.	Syn.	6600/13200	720
1250 HP	Whse.	Rev.	600	300/600
1000 KW	G.E.	Syn.	2300/4600	720
1000 HP	G.E.	MCF	600	350/700
1000 KW	G.E.	Syn.	2300/4160	720
350 HP	Whse.	Mill	250	325/650
300 KW	Whse.	Syn.	220/440	1200
200 HP	G.E.	CD-1656Z	250	500/1500
200 KW	Whs.	Syn.	440	1200

ALSO MANY OTHER COMBINATIONS

A. C. MOTORS—3Ph. 60 Cy.

SLIP RING

Qu.	H.P.	Make	Type	Volts	Speed
1	1500	G.E.	MT-498	2300	360
1	1000	A.C.	Mill	2300	240
1	700	Al. Ch.	D.P.	2300	500
1	500	Whse.	CW	550	350
1	500	G.E.	M-569Z	2200	1180
1	400	Whse.	CW-960A	440	1170
1	400	Whse.	CW	440	514
1	400	Whse.	CW-1218	2200	435
1	300	G.E.	IM-17A	440	2300/720

SQUIRREL CAGE

1	800	G.E.	KT-573	2200	1180
2	650	G.E.	FT-559BY	440	3570
1	500	G.E.	K-6345S	2300	1185
2	450	Whse.	CS-1420	2300/4150	354
1	400	G.E.	IE-15B	2300	1185
1	400	G.E.	IK	2200	500
1	200	G.E.	IK-17	440	580
3	200	G.E.	KT-557	440	1800

SYNCHRONOUS

1	4350	C.W.	2501-SL	13800/6900	514
1	1750	G.E.	ATI	2300	3600
2	2000	Whse.		2300	120
2	735	G.E.	ATI	2300/12000	600
1	500	Ideal	SM	2300/4160	1800
2	500	G.E.	TS-7567	2200	1200
1	450	Whse.		2200	450
1	400	G.E.	TS	2200	400

M-G SETS—3 PH. 60 CY.

Qu.	K.W.	Make	RPM	DC Volts	AC Volts
2	2000/2400	G.E.	450	250/300	2300/4600
1	2000	G.E.	600 25cy	600	11000
2	2000	G.E.	514	600	6600/13200
1	1750/2100	G.E.	514	250/300	4800/2400
1	1500	G.E.	720	600	6600/13200
1	1500	C.W.	514	30/115	4000/13000
1	1000	G.E.	720	600	2300/6600
1	1000	G.E.	900	600	6600
1	750	Whse.	900	250	2300/4150
1	750	C.W.	514	30/115	2300
1	750	G.E.	900	125/250	2300
1	600	G.E.	720	250	440/2300
1	500	Whse.	900	250	2300/4150
1	300	Whse.	1200	250	440/2300
1	250	A.C.	900	125	2300/4000
1	200	Whse.	1200	250	220/440
1	150	Whse.	1200	600	2300

SIX 1200 KW RECTIFIERS

Whse., D.C. output, 2800 Amp., 283/600 volts, with 1328 KVA, 3 ph., 60 cy., Transf., 11,000 volts and controls. Can furnish for other voltages.

TRANSFORMERS

Qu.	KVA	Make	Type	Ph.	Voltages
1	3000	Wagner	HPW-20	3	26400x2400
1	1000	Pitts.	OISC	3	26400/13200x2400
3	550	Kuhl.	OISC	1	2300x230/460
3	333	G.E.	HS-WR	1	2300/4000x230/460
3	333	G.E.	HD	1	13200x2530x4350Y
3	250	Penn.	OISC	1	34500x120/240

FREQUENCY CHANGER SETS

Qu.	KW	Make	Freq.	Voltages
1	12500	Whse.	60/25	13200/13200
1	5000	G.E.	60/50/60	6600/11000/6600
2	2500	G.E.	25/62.5	2300/2300
1	1000	G.E.	25/58.3	4400/2300
1	500	Al. Ch.	2500	11000/2300

TURBO GENERATORS

Qu.	KW	Make	Desc.
1	4000	G.E.	Condensing 425 — 750 F.T.T. Surface Condenser 3/60/2300/4000 V Direct conn exciter.
1	1500	Whse.	Auto. extraction 190 lbs.—600° F.T.T. 60 lb. extraction 3/60/240 V. Dir. conn. Exc.
1	1000	Moore	Auto-Ext. Cond. 175/200# I.S.P. 5/250 G. Ext. Surface Condenser—3/60/2300.
1	1000	G.E.	Non-condensing 175/200 lbs. I.S.P. 5/30 lbs. G.E.P., 480/3/60.

BELYEA COMPANY, INC.

43 Howell St., Jersey City 6, N. J.

CHECK WITH WAGNER FIRST

"Certified Rebuilt" Motors and Generators

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
200	Allis Ch. b.b.	EW	350	1000
200	Allis Ch. b.b.	EW	250	650
150	Whse.	SK-201	230	300/900
150	Whse.	SK-184	230	850
100	Whse.	SK-173	230	850
100	Reliance	651T	550	1000/1600
100	Reliance	651-T	230	575/1150
75	Cr. Wh. TEFC	53H	230	850
75	F. Morse b.b.	DH-140	115	1600
50	Whse.	SK-113	230	1750
50	G.E. dynam. (4)	TLC25	250	1000/3500
50	Whse. (2)	SK-143	230	850
40	Whse. (3)	SK-133	230	850
30	Imperial b.b.	D80	230	400/1600
30	Star b.b. (3)	SB	230	1750
25	L. A. TEFC	RNA	220	850

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V.
500	Whse.*	2300 AC	250 DC
250	Allis Ch.	2200.440 AC	250 DC
200	Whse.*	220/440 AC	55 DC
200	Gen. Elec.*	220/440 AC	125 DC
200	Whse.*	220/440 AC	250 DC
150	Gen. Elec.	220/440 AC	125 DC
150	Whse.	2200/440 AC	275 DC
125	Gen. Elec.*	2300/4000 AC	250 DC
105	Century b.b	220/440 AC	70 DC
100	G.E.*	2200/440 AC	125 DC
100	Whse.	220/440 AC	250 DC
75	F. Morse b.b.	220/440 AC	125/250 DC
75	Whse.	2200/440 AC	500 DC
60	Gen. Elec.*	220/440 AC	60 DC
50	Gen. Elec.	220/440 AC	125 DC
50	Whse.	220/440 AC	250 DC
40	Whse. (2)	220/440 AC	250 DC
30	Gen. Elec. (2)	220/440 AC	125 DC
30	F. Morse b.b.	220/440 AC	24 DC
30	Allis Ch.	220/440 AC	250 DC
25	Whse.	220/440 AC	125 DC
20	Rel. b.b. (2)	220/440 AC	250 DC

200 KW M-G SET—LIKE NEW
Whse. DC 250 V. gen. w/synch. motor. 3/60/220/440 V.. inel. AC & DC control. Quick shipment, low cost, guaranteed.

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
250	Allis Ch. b.b.	EW	350	1200
175	Allis Ch. b.b.	EW	250	900
150	Whse.	SK-184	250	1150
105	Century b.b.	1500 amp.	70	1200
100	Whse.	SK-173	250	1150
100	Allis Ch.	E	125	1200
100	Reliance	651T	600	1200
75	F.M. b.b.	DG	125/250	1200
75	F.M. b.b.	DG	135	1800
75	Cr. Wh. bb (2)	CCD	250	1150
75	Whse. b.b.	SK-163	125	1000
50	Whse. (2)	SK-143	250	1150
40	Whse.	SK-123	250	1150
25	G.E. b.b. (10)	CD85	230	2200
25	Whse.	SK93	125	1750

A. C. MOTORS — 60 CYCLE

HP	Mfr.	Type	Volts	Speed
700	G.E.	Synch.	2200	514
700	Allis Ch.	Sq. Cage	440	900
700	G.E.	Synch.	2200/440	1200
600	G.E.	Slipring	2300	600
600	G.E.	Synch.	2200	327
500	G.E.	Sq. Cage	2200	3600
500	G.E.	Sq. Cage	4000	1800
450	Allis Ch.	Synch.	480	400
400	G.E.	Slipring	2200	900
400	Whse.	Sq. Cage	2200	514
400	G.E.	Synch.	440	450
300	Gen. Elec.	Slipring	220/440	1200
300	Whse.	Sq. Cage	440	400
300	El. Machy	Synch.	220/440	360
300	Al. Ch.	Sq. Cage	2200/440	720
300	G.E.	Slipring	440	360
250	Whse. X-P	Sq. Cage	2200	3600
250	Burke	Synch.	220/440	360
250	G.E.	Slipring	220/440	720
250	G.E.	Sq. Cage	220/440	900
250	Gen. Elec.	Synch.	220/440	450
250	G.E.	Synch.	220/440	720
250	L.A. (2)	Sq. Cage	2200	1800
225	G.E.	Synch.	220/440	900
200	Whse. (2)	Slipring	2200/440	720
200	Gen. Elec.	Sq. Cage	220/440	1200
200	Reliance b.b.	Sq. Cage	220/440	1800
200	Allis Ch.	Slipring	440	450
200	Gen. Elec.	Sq. Cage	2200/440	720
200	Cr. Wh.	Sq. Cage	220/440	3600
200	Whse.	Sq. Cage	2200/440	900
200	E. M.	Synch.	220/440	1200
175	G.E. (2)	Synch.	220/440	720
150	Allis Ch. (2)	Slipring	220/440	1200
150	Allis Ch.	Slipring	2200/440	720
150	G.E. (2)	Sq. Cage	2200/440	720
150	Rel. b.b.	Sq. Cage	220/440	1800
150	Allis Ch.	Sq. Cage	440	450
150	G.E. vertical	Slipring	4000/2200	1200
125	G.E.	Slipring	220/440	720
125	G.E. TEFC	Sq. Cage	220/440	3600
125	Whse.	Sq. Cage	220/440	900
125	Rel. TEFC	Sq. Cage	220/440	1800
125	G.E.	Slipring	220/440	450
125	Allis Ch.	Slipring	220/440	900
100	G.E.	Slipring	220/440	720
100	L. Allis b.b.	Sq. Cage	440	3600
100	G.E.	Slipring	220/440	514

A. C. GENERATORS — 60 CYCLE

KVA	Mfr.	Type	Volts	Speed
1000	Whse. syn cond		4000/2300	900
700	Gen. Elec.	ATI	2300/480	1200
625	Gen. Elec.	ATB	2300	450
485	Allis Ch.	1 brg.	480	400
312	Gen. Elec.	ATB	240/480	600
275	G. E. 25 cycle	ATI	480	750
235	El. Machy.		480	720
225	Gen. Elec.	ATI	240/480	900
156	Whse.	C	240/480	1200
150	Whse.		2300/480	600
75	El. Machy.		2300	900
56	G.E.	ATB	240/480	1200
37½	Whse.		240/480	1200

ARTHUR **WAGNER** COMPANY
1435 W. RANDOLPH ST.
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TELEPHONE MONROE 6-7409

COAL HANDLING SYSTEM FOR SALE

150 Ton Per Hour Link Belt Co. Conveyor Type System in Good Condition

The system consists of a steel track hopper, track girders, grids, reciprocating feeder, 30 inch feeder conveyor with magnetic head pulley, coal crusher, 24 inch stocking out conveyor, 24 inch elevating conveyor and weightometer, 24 inch distributing conveyor and automatic self propelled tripper. The system is complete with transfer chutes, structural supports, belts, belt canopy, idlers, drive motors, etc.

— ALSO —

One Robins car shakeout with single speed trolley drive twin hook hoist.

Located in Oklahoma — Available for Immediate Delivery

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6—100 KVA 60 cy. 1 ph. O.I.S.C. Transformers 2400-120/240.
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19—15 KVA 60 cy. 1 ph. Dry Type 240/480-120/240
15—25 KVA 60 cy 1 ph. Dry Type 240/480—120/240
8—37½ KVA 60 cy. 1 ph. Dry Type 240/480—120/240.
3—50 KVA 60 cy. 1 ph. Dry Type 240/480—120/240.
3—10 KVA 60 cy 3 ph. Dry Type 480—208Y/120.
2—37½ KVA 60 cy 3 ph Dry Type 480—208Y/120.

ATLANTIC TRANSFORMER CO.
5143 N. 2nd St., Phila. 20, Pa.
Phone: Michigan 4-6963

37 Years Dependable Service

SLIP RING MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Speed
600	2300	Whse.	450
400	440	Whse.	514
450	440	Whse.	720
400(2)	2300	G.E.	900
200	2300/440	G.E.	720
300	440	G.E. (hoist)	600
300	2300	G.E.	360
300	440	Whse.	3600
250	440/220	Whse.	600
250	550/440	G.E.	1200
225	4000/2300	G.E. (hoist)	600
200	440/220	Whse.	514
150(2)	440/220	G.E.	720
150	2300/440	G.E.	600
125	440/220	G.E.	900
125	550/440	G.E.	1200
125	2300	G.E.	600

SYNCHRONOUS MOTORS 3-Ph 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2300/440	G.E.	ATI	720
375	440/220	Whse.	VI	300
250	440/220	Ki. Machy.	Syn.	1200
200	2300/400	G.E.	TS	720
200	2300/440	G.E.	TS	1200
250	2300/440	G.E.	TS	720
250	440/220	Whse.	HR	277
250	440/220	G.E.	ATI	600
125	440/220	Whse.	MR	400

SQUIRREL CAGE MOTORS

H.P.	Volts	Make	Type	Speed
600	2300	G.E.	KT	3600
500	2300/4000	Elliot	SC	1800
500	2300	G.E.		450
400	2300/4000	Whse.	CR	720
400	2300/4000	G.E.	K	1800
350	440	G.E	KT	1200
300	2300/4000	L. Allis	PR	1800
250	2300	G.E.	K	900
225(2)	2300/440	G.E.	KT	1200
200	440/220	G.E.	KT	1200
200	2300/440	G.E.	JK	600
200	2300	G.E.	KT	1800
150	2300	Al. Chal.	AR	1800
150	220	Whse.	CR	1200
150	440/220	G.E.	KT	720
150	2300/440		KT	600

A. C. GENERATORS

1—320 kva, 650 rpm 2300/440/220 V, G.E.
1—300 kva, 900 rpm, 480/220 V, G.E.
1—225 kva 60 rpm, 220/440 V., G.E.
1—200 kva, 720 rpm 2200/440 V., G.E. (Ball)
1—187 kva, 1200 rpm, 2200/450 V., Whse.

CIRCUIT BREAKERS

2—2000 amp. GG E., 2 pole, 600 V.
2—1600 amp. ITE, 3 pole, 600 V.
6—FKM-155-28, 600 amp., 15,000 V. G.E.
1—600 Amp., Condit. 2P, 25 KV outdoor
1—400 Amp., R. Smith, 2P, 7.5 KV outdoor

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
225	230	Whse.	SK	2870
150	230	Whse.	SK	1750
90	230	G.E.	CD	1750

MOTOR GENERATOR SETS

KW	Make	Input V., AC	Motor Type	Output V., DC
250	Whse.	2200	Syn.	250
200	G.E.	440/220	Syn.	250
175	G.E.	220/440	Syn.	230
125	G.E.	4000/440	Syn.	125
125	G.E.	440/220	Syn.	250/125
100	Al. Ch.	220/440	Sq. Ca.	240/120
65	G.E.	2200/440	Sq. Ca.	250

TRANSFORMERS 60 Cy.

1—1000 kva, Whse., 13,800—2300 V., 3 ph., New
1—600 kva, Standard, 13,800—2300 V., 3 ph.
2—500 kva, Whse., 66000—2300 V.
2—333 kva, G.E., 23000/11500—2300 V.
2—333 kva, Mol., 13,800—2300 V.
2—333 kva, G.E., 2400—480 V.
2—300 kva, G.E., 4150—240 V., 3 ph., Pyr.
2—200 kva, Mol., 13,800—2300 V.
2—200 kva, G.E., 2300—575 V.
2—100 kva, Al. Ch., 2400—480/240 V.

only partial listing

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HARRY J. RICE, Pres.
625 ADAMS ST., HOBOKEN 2, N. J.

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3 NEW VERTICAL CIRCULATING PUMPS

STEAM TURBINE DRIVEN

Manufactured by Warren Steam Pump Co.—26,500 GPM at 13.5 lbs. and 840 RPM. Test pressure 50 lbs.—submergence 72" water—suction lift 8" Hg. Westinghouse turbine—steam pressure 575 lbs. G.—Superheat 0 F—exhaust pressure 15 lb. G.—HP 300—RPM 4150—Type 20-V-R-G-B—steam chest pressure 900 lbs.—serial No. Pump 23706-23708-23707—Turbines 5A1034-51-50-44.

COCHRANE DEAERATOR

Maximum pressure 20 lbs.—220,000 lbs. per hour—1800 gallons storage volume.

THE BOSTON METALS CO.
313 E. BALTIMORE STREET
BALTIMORE 2, MD. Curtis 7-5050

PUMPS

2—24" x 24" Dayton Dowd Centrifugal, 18,000 GPM, at 35' Hd.
1—5" x 10" McGowan Hydraulic, 185 GPM, 500 PSI, #30005
1—3½" x 10" Worthington Hydraulic, Type D1654, 85 GPM, 500 PSI, #978859

TRANSFORMERS

100—1½ KVA, Line Material, Dry type, 120/240/480 volt primary 120/240 volt secondary with taps, 1 phase, 60 cycle
3—150 KVA, Maloney, OISC, 4000 volt primary, 230/460 volt secondary, 1 phase, 60 cycle
3—250 KVA, General Electric, OISC, 2300 volt primary, 460/230/115 volt secondary, 1 phase, 60 cycle
6—500 KVA, Westinghouse, OISC, 2300 volt primary, 460/230 volt secondary, 1 phase, 60 cycle

M.G. SET

500 KW, West. 250 V DC—714 HP, AC synchroneous drive, 3/60/2300/900 Factory Set.

BENSON-WILIMZIG, INC.
1704 North 8th St., St. Louis 6, Mo.
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BOILERS

High Pressure: Erie City, WP125, 250 HP, new 1941 Fitzgibbon, WP 125, 140 HP, new 1941.

Low Pressure: 3 Pacific Catalog #75-S-1, 228 HP, Water 30 lbs., Steam 15 lbs. new 1945.

All these units are from deactivated Government installations: the condition is excellent.

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FOR SALE

SPALDING PRECIPITATOR

Cap. 500 GPM Unit designed for future increase to 1000 GPM. Excellent condition. Bargain. Available January, 1956.

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500' Sections 42" Wide Belt Conveyors
30 HP 200# Pressure Erie City Boiler
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2—16,000 & 1—12,000 Gal. Horiz. Stor. Tanks
125 & 200 HP Slow Speed Rebuilt Motors
D-13,000 Cat. Diesel with clutch
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625 KVA SKINNER UNIFLOW UNIT

1—625 KVA Electric Machinery generator, 3 phase 60 cycle 4160/2400/480/240 volts, 150 RPM, direct connected to Skinner universal uniflow engines, 125-165# steam pressure, 0-5# back pressure
Now 1949—Excellent condition.
INTERNATIONAL POWER MACHINERY CO.
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1—25 KVA—GE Curtiss Turbo Generator 3-60-2300V—3600 RPM, 18-8-2 4 stage turbine condenser
1—18" Worthington Cent. Pump LCS-2—2 stage—270' head, 12140 GPM, 1500 HP G.E. Syn. motor, 3-60-2300V
1—20" Worthington Cent. Pump, 12140 GPM—40' head
HARRIS MACHINERY COMPANY
501 30th Avenue S. E., Mpls., Minn.

FOR SALE
LOW VOLTAGE M. G. SET

H. V. W. M. CO. 15,000 Amp., 12 Volt, 7500 Amp. 24 Volt Generator driven by 300 H.P., 2200 Volt, 3 phase, 60 cycles, 180 Rpm. Syn. motor. With complete gen. control panel and full voltage magnetic contactor type sym. motor starter.

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We Carry Complete Stocks of

GUARANTEED "REBUILT" EQUIPMENT

WRITE FOR CURRENT STOCK LIST OR PHONE CANAL 6-2900

D. C. MOTORS

*230 Volt

HP	MAKE	TYPE	SPD.
250	Westg.	SK-220	450/600
200	Westg.	SK-201	650
200	Cr-Wh.	CM	500
175	G.E.	EL*	750
100	G.E.	MPC	400/800
100	G.E.	RC-34	2500
100	G.E.	RC-19	975
75/75	Westg.	SK-151	400/1600
50/120	G.E.	MCP	250/1000
50	Cr-Wh.	CMC	700/1100

MOTOR GENERATOR SETS

KW	MAKE	A.C.	D.C.
1000	G.E.	13,200	600
500	Westg.	2300	250
100	Al-Ch.	2300	120/240
150	G.E.	2300	270
300	G.E.	2300	250
300	G.E.	2300	250/275
200	Westg.	4160/2200	275
200	Ridgeway	2300	250
170	G.E.	440	125
150	Al-Ch.	2300	275

SPECIALS!!!

PLATING GENERATOR SETS

AMPS	D.C.	MAKE	A.C.
7500/3750	6/12	Elec. Pdts.	220/440
2000/1000	6/12	Chandy	220
1500/750	12/24	Chandy	220
1500-750	6/12	Chandy	220
1000/500	12/24	Chandy	220
250	12	Hannon & VW	220/440
220	6	Holtzer-C	220

SPEED REDUCERS

HP	MAKE	MAX SPEED	TYPE & RATIO
25*	W.A. Jones	1200	210 SH; 5.63:1
15*	W.A. Jones	1200	140 SH; 5.63:1
2*	Falk	1750	3026E; 9.304:1

CAPACITORS

36—15 KVAR Cornell Dubilier, type DH-11, 460 v./3 Ph./60 Cy. Indoor dust-tite, fireproof, non-explosive capacitors, complete with indiv. fuses & discharge resistors.

SYNCHRONOUS MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

HP	MAKE	TYPE	PF	SPD
1420	*West.		.7	900
800	G.E.	TS-EL	1.	1200
700	G.E.	TS-EL	.8	1200
600	*G.E.	TS-7640	1.	900
500	*G.E.	TS-7637	1.	514
400	*West.	H	.8	1800
400	West	HG	1.	900
300	G.E.	ATI	.8	720
300	*Ideal	SMM	.8	257
300	G.E.	ATI	.8	900
250	G.E.	ATI	.8	900

SQUIRREL CAGE MOTORS

3 phase 60 cycle, 220 or 440 volts (*2300 volts or higher)

HP	MAKE	TYPE	SPEED
1250	*Al-Ch.	ANW	3600
1250	*Al-Ch.	ANW	1200
800	*Westg.	CW	3600
800	*Westg.	CW-1483	1800
700	*Westg.	CW	1200
700	Al-Ch.	AN	900
500	*Al-Ch.	6316 SW	1800
500	G.E.	KT-424	450
400	G.E.	KT-424	360
350	Ideal	A	1800
300	*G.E.	K-4314Y	1200
300	G.E.	K-8358 TKPA	720
250	G.E.	KT-5008	1800
250	*L. Allis	00K-148	720
250	*G.E.	IK	600
250	G.E.	IK-17A	900

SLIP RING MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

HP	MAKE	TYPE	SPEED
2000	*G.E.	MT	600
1500	*G.E.	MT-30	240
1250	Westg.	CW	600
1000	*Westg.	CW	450
700	*Al-Ch.	ANY	720
500	Westg.	CW	350
400	Al-Ch.	3 brg.	450
400	G.E.	IE-17	720
300	*G.E.	IK-15A	1800
250	Westg.	HP-15H	600
250	*G.E.	I-17B	450
200	G.E.	IK-15B	900
200	G.E.	IM-17	600

CHICAGO *Electric Co.* **1320 WEST CERMAK RD, CHICAGO 8, ILL.**

FOR SALE

1—General Electric Generator 320 KW—AC—400 KVA at .8 P.F. 600 volt—385-Amps.—200 RPM, 3 PH, 60 CY, #1,012,290, Type ATB-36-400M, form S, 123 Max. D.C. excitation, with base 2 bearings & motor operated field rheostat.

1—Exciter 14 KW, 125 volts, 112 Amps., 750 RPM, type CVC-116, form AA1053, #459026 compound wound, with pulley, base and field Rheostat.

CROCKER-McELWAIN CO.
P.O. Box 987 Holyoke, Mass.

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MOTORS AND GENERATORS
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New Release of Government Surplus Material

Model #S-9527. KENYON TRANSFORMER CO. — 3.2 KVA. Input 110/220 Volts 50/60 Cy. Output 11 Volts C-T (5.5-0-5.5) At 200 Amperes! Continuous Duty. Case Size 8¼ x 10½ x 12".

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#S-9527-WE. — WESTINGHOUSE. — Same Specs. But Single 115 V Input & Lighter Wt. NEW $23.95

DOZENS OF USES FOR INDUSTRIALS, TESTING LABS, EXPERIMENTAL UNITS & SCHOOLS

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* Magnetizers * Heat-Treating * Electromagnets
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McNEAL ELECTRIC & EQUIPMENT CO.
4736 Olive St., Dept. P-12, St. Louis 8, Mo.

Rebuilt

HEMPHILL *Guaranteed* EQUIPMENT

TRANSFORMERS 60 CYCLE

Qu	KVA	Make	Type	PH.	Voltages
1	1000	Amer.	Pyranol	3	4150x480
1	750	G.E.	HT	3	4150x120/240
2	750	G.E.	H	1	4800x120/240
*2	400	Pitts.	OIBC	1	4150x240/480
3	75	G.E.	Pyranol	1	2400/4160-240/480
3	50	G.E.	H	1	2400/4800-120/240
1	25	G.E.	Pyranol	1	2400/4160-120/240
3	200	G.E.	H	1	7500/13800-440/220
3	150	Amer.	OIBC	1	2400/4160-240/480

SYNCHRONOUS MOTORS

QU	HP	Make	Speed	Type	Volts
1	1400	G.E.	514	ATI	4150
1	1000	Whse.	225	MIII	2300/4150
1	1000	West.	200	MIII	2300/4150
1	500	Whse.	450	HR	2300
1	300	EM	720	TEFC	2300
1	300	G.E.	600	ATI	220/440/2400
1	200	Whse.	600	ATI	440
3	150	G.E.	1200	TS	4150
1	150	G.E.	1800	TS	220
2	150	Allis	580		2200
1	125	EM	900		4800
1	100	G.E.	900	TS	2200

SLIP RING MOTORS

QU	HP	Make	Speed	Type	Volts
1	500	G.E.	1200	M	2400/4150
1	400	Whse.	455	CW	450
1	250	Whse.	600	CW	440
1	200	Whse.	600	CW	440
3	150	A.C.	1800	AT RW	2300
1	100	G.E.	1800	IM	220
1	100	G.E.	600	MT	440
1	75	G.E.	600	IM	440
1	60	G.E.	1800	MT	220
1	200	Whse.	500	CW	440

MOTOR GENERATOR SETS

Qu	KW	Make	Speed	DC	AC
1	1000	G. E.	514	600	2300/4150 3yn
1	1000	Whse.	720	600	2300/4150 3yn
1	1000	Whse.	720	275	2300/4150 3yn
1	300	G.E.	1200	250	2300/4150 3R
1	200	Whse.	900	250	2300/4150 3yn
1	150	C.W.	600	125	220/440 Y
1	100	G.E.	900	250	2300 3yn
1	97	G.E.	1200	60	4150 3yn
1	75	G.E.	1800	250	220/440 3C
1	60	Whse.	1200	60	2300Y
3	60	EM	1200	125	220
1	30	Whse.3K	1750	250	2300/4150 3yn
1	20	EM	1800	125	220 Y
1	7½	Allis	1360	125	220/440
2	5	G.E.	1800	125	220/440
2	3	G.E.	1800	250	220/440
2	20	G.E.	1800	1725	220/440 Y

DC, 230 VOLT MOTORS

Qu	HP	Make	Speed	Type
2	150	C.W.	900	WF
1	125	G.E.	1700	RC
2	75	C.W.	900	WF
3	30	C.W.	700	CM
3	25	G.E.	850	RC
1	25	Whse.	835	MK
1	30	G.E.	1650/1800	CDM85

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1603 54th STREET, NORTH BERGEN, N. J.
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3000 KW MODERN POWER PLANT—COMPLETE

NEW 1949 ***LITTLE USED***

3000 KW Turbo generator, Allis Chalmers 3600 RPM 3/60/2300/4600 Volts 400# 600° FTT cond. 28" Vac.

50000 lbs/hr Boiler, Union Iron Works, 450 psi incl. stokers with traveling grates

WITH ALL AUXILIARIES

HUGO NEU CORPORATION

31 Nassau St. Tel: REctor 2-1334 New York 5, N. Y.

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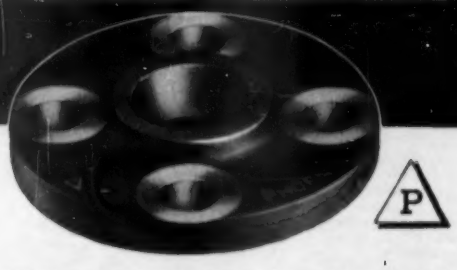

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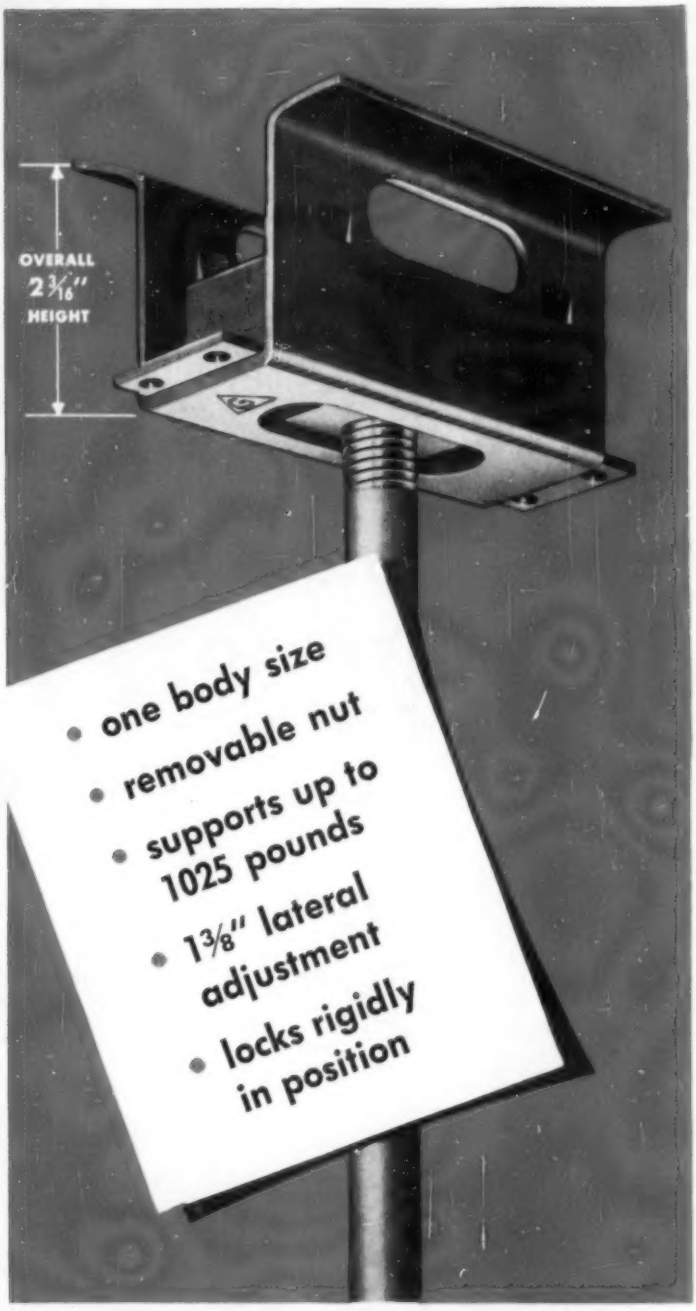

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